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REPORT #6014

DEVELOPMENT OF A 7.62MM COLD-WORKED STEEL CARTRIDGE CASE

BY

PHILIP B. TAYLOR

April 1971

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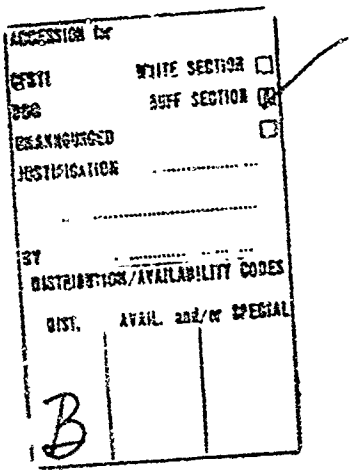

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DEVELOPMENT OF A 7.62MM COLD-WORKED STEEL CARTRIDGE CASE

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Ammunition Development and Engineering Laboratories
FRANKFORD ARSENAL
Philadelphia, Pa. 19137

April 1971

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SUMMARY

This report covers the development of a 7.62MM cold-worked cartridge case by the blank-cup-and-draw process at Frankford Arsenal. Processing of pilot lots of cases was performed in-house, and the cartridges thus produced were proof-tested. Various grades of low-carbon steel strip supplied by different manufacturers were evaluated for formability and ballistic performance. Cases produced of C1025 steel, 0.24 carbon, from two different manufacturers, were found to be most satisfactory, both in processing and in proof testing.

While firing test results indicate that a cold-worked steel case can be manufactured to acceptable quality levels, much additional development and product improvement must be performed before the case will perform at a level comparable to the performance level of the present 7.62MM brass case. The areas requiring improvement are inspection, surface finish, processing equipment, and cost reduction. Recent advances in steel making and coating technology should aid in the development of an entirely satisfactory cold-worked steel case.

This report is organized in sections covering the major aspects of the cold-worked steel case effort at Frankford Arsenal. The Process section relates in detail each operation in the manufacturing process. Additional details of tools and equipment may be found in the appendices. The Process Metallurgy section describes the metallurgical changes which take place during processing of a lot of cases. The Proof Testing section gives results of simulated acceptance tests performed on each pilot lot of steel-cased cartridges. Conclusions and Recommendations resulting from the study may be found at the end of the report.

FOREWORD

Under the Army-wide copper conservation program of 1966, Frankford Arsenal was assigned the problem of developing and manufacturing a pilot quantity of 7.62MM ball M80 and tracer M62 NATO cartridges, assembled with steel cases. This task was processed to completion, using a process calling for quenching and tempering of the completed cartridge case before varnishing.

Due to the problems and cost associated with the quenching and tempering operations necessary to achieve desired hardness, studies were made to determine the feasibility of manufacture of a case wherein the hardness is derived through cold working of the steel.

Successful cold worked 7.62MM cases have been developed and tested by other countries, including several NATO nations. While the Frankford Arsenal cold worked case has not undergone a complete series of Engineering and Service Tests, ballistic testing at Frankford Arsenal has indicated that this case can be manufactured to tolerance levels acceptable to both U.S. and NATO specifications.

Case Lot Identification

A total of ten lots of 7.62MM steel cased cartridges were manufactured at Frankford Arsenal during the period from February 1967, to December 1968. These lots are summarized in Table 1, which shows the significant process differences among the ten lots.

Not included in Table 1 are two lots of cases cupped from strip which were not completed due to difficulties encountered during processing.

The first of these lots, identified as lot 310-A-1, using Allan Wood 1025 steel (.23C.), was suspended at 4th draw due to a high percentage of split mouths at 2nd and 3rd draws and mouth shears at 4th draw.

The second lot found unsatisfactory during processing was cupped from United States Steel Corp. carbon boron steel (.16C, hot rolled), and was likewise suspended at 4th draw. Failures consisted mainly of partial circumferential ruptures in the case body approximately 1/2 inch from the head. Metallurgical examination of the components involved revealed inclusions present in the material in sufficient quantity to justify suspension of any future production of cases from this material.

Figure 1 shows the process used for production of lots 11A1, 11A2, 11B1, and 11B2. The process finally developed as a result of the study is shown in Figure 2.

TABLE I

PROCESS SUMMARY - COLD WORKED CASE LOTS

Lot No.	Steel Supplier	Steel Grade	Date Completed	Anneal for 1st Draw	Anneal for 2nd Draw	Anneal for 3rd Draw	Stress Relief After	Body Anneal
11A1	Republic	1025	Jun 67	*	None	1220°F	Head	Gas
11B1	Republic	1025	Jun 67	Annealed 1320°F	None	1220°F	Head	Gas
11A2	Republic	1025	Jun 67	*	None	1320°F	Head	Gas
11B2	Republic	1025	Jun 67	Annealed 1320°F	None	1320°F	Head	Gas
310-B-1	Republic	1026	Aug 68	Annealed 1320°F	None	1320°F	Vent	Gas
310-C-1	Sharon	1025	Aug 68	Annealed 1320°F	None	1320°F	Vent	Gas
310-D-1	Republic	1030	Aug 68	Annealed 1320°F	1320°F	1320°F	Head	Induction
310-F-1	Republic	1025	Aug 68	Annealed 1320°F	1320°F	1320°F	Head	Gas
310-C-2	Sharon	1025	Dec 68	Annealed 1320°F	1320°F	1320°F	Head	Induction
310-C-3	Sharon	1025	Dec 68	Annealed 1320°F	1320°F	1320°F	Head	Gas

* Cups heat treated at 1690°F, water quenched and tempered at 1290°F.

7.62 MM STEEL CTG CASE COLD WORK PROCESS

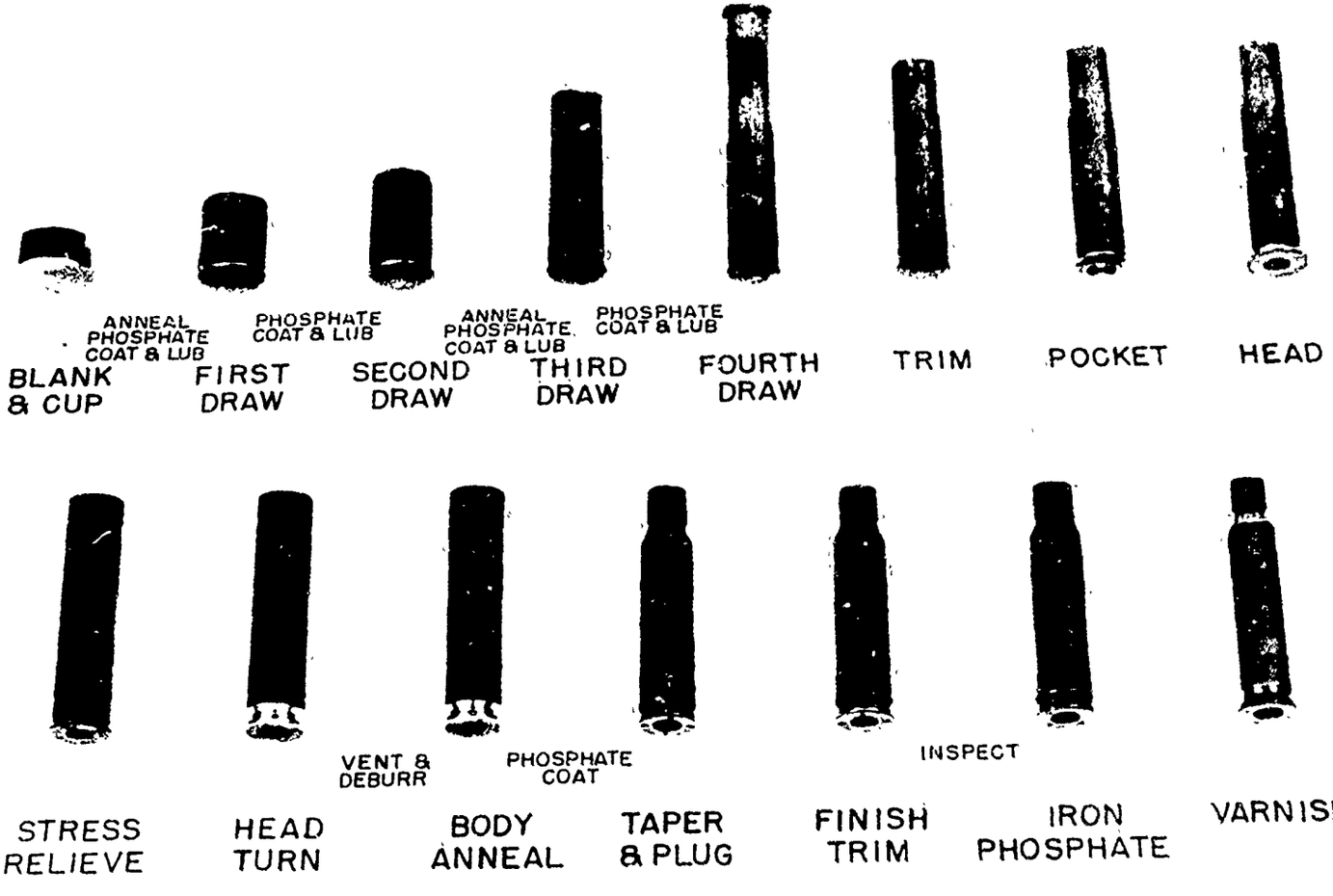


Figure 1

7.62MM STEEL CRTG CASE COLD WORK PROCESS

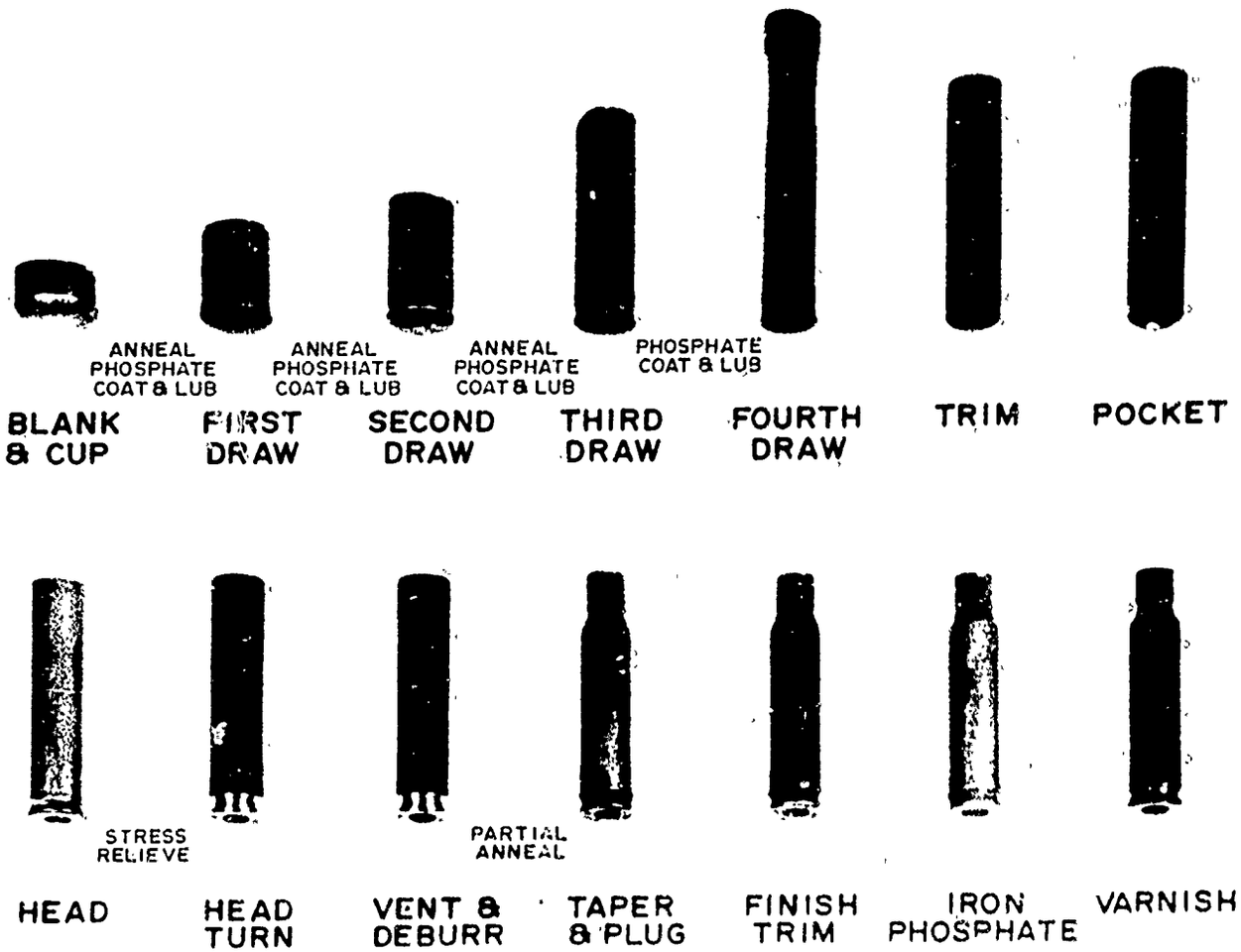


Figure 2

PROCESS

This section covers the process developed for pilot manufacture of 7.62MM cold-worked steel cases. Initial lots of cases (11A1, 11A2, 11B1, and 11B2) were produced using slight process variations until proof-test results indicated that a satisfactory process had been established. These variations are shown in Table I. Appendix A shows the manufacturing process used for lots 310-B-1, 310-C-1, 310-D-1, 310-F-1, 310-C-2, and 310-C-3. Appendix I shows the final manufacturing process developed and recommended for future production. Operations described in this section follow the sequence given in Appendix B. Dimensions and configurations of process pieces are shown in the sketches of Appendix C.

Blank and Cup – Blanking and cupping from steel strip was performed at Frankford Arsenal for the production of approximately 1,100,000 7.62MM steel cases, the great majority of which were processed into heat treated cases. However, the methods used to fabricate the cups are applicable equally to the cold work process, since the cups used for both processes are identical. (See drawing No. X10535793A.)

The press used for blanking and cupping was a Bliss #6 double acting press equipped with twin flywheels, operating at approximately 90 strokes per minute. The die set used with this press contained five stations, allowing up to five cups to be made with each press stroke. A single die was used at each station for completely forming the cup. No sizing die was employed.

As stated in "Material Requirements", blanking and cupping was accomplished using oiled strip as received from the steel supplier, without the benefit of zinc phosphate coating. Lubrication of the unphosphated strip proved to be a continuing problem to which a completely satisfactory solution was never found. Lubro-44, manufactured by G. Whitfield Richards, proved to be the most successful lubricant tried, particularly when mixed with Lubri-Cool, manufactured by Lord Laboratories, Detroit, in the amount of one pound of Lubri-Cool to 55 gallons of Lubro-44 solution. For production purposes, a lubricant concentration of 1 part Lubro-44 to 1 1/2 parts water was found to be most satisfactory.

Lubricant solution was applied to the tools through use of the circulating system incorporated in the press design. Streams of lubricant were directed onto the top of the stripper plate to achieve a puddling effect on top of the strip. In addition, streams were directed under the strip, between the strip and the die block. In both of these approaches, flow of coolant into the die ceases as the blanking punch brings the underside of the strip into contact with the top surface of the die.

Due to the lack of a sizing die, injection of lubricant through a lube ring located below the blank and cup die was precluded. Consideration was given to the use of jets to direct a high-pressure stream of coolant upward into the die, but this method was never attempted.

Various die coating methods were attempted to reduce the rate at which the dies pick up steel from the strip. It was found that pickup reached an intolerable level after approximately 1,000 pieces, using chrome plated dies.

Rate of pickup was reduced through the use of manganese phosphated dies which were coated with Serf-Cote M1291, a matrix-bonded solid film lubricant manufactured by Hohman Plating and Manufacturing Co., Dayton, Ohio. This lubricant, qualified under MIL-L-8937, extended the interval between polishing of dies to approximately 8,000 pieces.

Die life, using a mixture of Lubro-44 and Lubri-Cool, with uncoated dies manufactured from FS-W1-10 or FS-W1-12 steel, is estimated to be approximately 25,000 pieces.

In an effort to determine the effects of zinc phosphate coating of strip on blanking and cupping, 32 strips, each seven feet long, were cut from a coil and phosphate coated. These strips (approximately 4,000 pieces) were processed with comparative ease: most problems were eliminated, and tool life and production were increased. A process was also tried wherein partially-formed cups were made from unphosphated strip. Results were encouraging, although the partial cups were formed with very rough edges. Plans called for phosphating and final forming on a modified first draw press; while this task was never completed, results appeared promising for further development.

Wash and Rust Prevent – Following the blank and cup operation, the cups were washed to remove all traces of dirt and lubricant and thereby prevent the formation of residue on the pieces during annealing. The rust preventative, consisting of a final rinse in potassium dichromate solution, retards rust formation during short periods of storage and need not be removed prior to annealing.

The machine used to accomplish this operation was a Baird, inclinable barrel, rotary washer. The cups are contained in the barrel and are washed and rinsed as the barrel rotates. The tumbling action produced by an auger inside the barrel removes any burrs present, resulting from the blank and cup operation.

Washing solution was prepared by dissolving four cups of tri-sodium phosphate in hot water. A washing time of 1/2 hour was found to be sufficient.

Anneal for First Draw – In all lots of cold worked cases, the cups were annealed prior to first draw to recrystallize the basic ferrite grains. The purpose of this anneal was to reform the spheroidized structure present in the steel strip as received from the manufacturer and thereby increase the ductility of the material, making it suitable for additional forming. Hardness of the annealed pieces was kept at or below RB66 at a position on the sidewall 1/15" from the base.

The furnace used for annealing was a Lindberg electric three-zone retort-type furnace, with a controlled atmosphere of carbon monoxide to prevent oxidation and scale formation on the pieces. A cooling chamber is incorporated to prevent contact of the heated pieces with the outside atmosphere.

Temperature within the retort is controlled by zones: entrance, center and discharge. During the annealing cycle, all zones are maintained at 1320°F (outside retort). Due to heat loss in transfer through the wall of the retort, the temperature of the pieces is maintained at approximately 1290°F.

Heating and cooling times (51 minutes each) used were the maximum times available with the furnace used, which gives a minimum speed of rotation of approximately 0.6 RPM.

Two lots of cases manufactured early in the program (see Table I) utilized a quench and temper operation to condition the cups for first draw. For this operation, a muffle furnace was employed to heat the pieces to a temperature of 1690°F. The pieces were then quenched upon removal from the furnace, and tempered at 1290°F.

Quenching and tempering eliminated spheroids, resulting in a tempered, possibly laminar, structure having very fine carbides. This structure is harder to form than the spheroidized structure, but possesses superior properties. However, a complete quench could not be obtained due to the thickness of the material, and the 1320°F anneal was adopted for future production.

Phosphate Coat and Lubricate – Following annealing, the cups were cleaned, pickled, zinc phosphated, and lubricated prior to first draw. The procedure, consisting of seven sections, is as follows:

Section	Treatment	Agent	Temp	Minutes	To remove
First	Clean	Alkaline Solution	190-200°F	10	Foreign matter
	Drain			2	
Second	Rinse	Water	150-170°F	4	Solution
	Drain			2	
Third	Pickle	Sulfuric Acid Sol'n	145-155°F	8	Oxidation
	Drain			2	
Fourth	Rinse	Water	Cold	2	Acid Sol'n
	Drain			2	
Fifth	Coat	Zinc Phosphate	170-180°F	10	- - -
	Drain			3	
Sixth	Rinse	Water	Cold	2	Excess Coating
	Drain			2.5	
Seventh	Lubricate	*		8	- - -

* Supplied by phosphate manufacturer

In the first section operation, the pieces are cleaned to remove all traces of dirt, grease, and other foreign matter present from annealing and handling. The solution used is a mixture of Cleaning Compound FX-2, manufactured by Amalgamated Chemical Corporation; caustic soda flakes; and hot water. Details on solution mixing may be found in Universal Solution Mixing Section, Operation No. U-66.

The third section operation is a sulfuric acid pickle, the purposes of which are to remove oxidation from annealing, and to etch the surface of the pieces prior to zinc phosphating, providing a surface to which the coating will adhere. Pickling solution is prepared in accordance with Universal Solution Mixing Section, Operation No. U-165.

The zinc phosphate coating, applied in the fifth section operation, is an adherent film used to retain the lubricant film. The compound used is Bonderite 160X, purchased from the Parker Rustproof Company. The solution is prepared according to Universal Solution Mixing Section, Operation No. U-166.

In the seventh section operation, the lubricant coating is applied to the zinc phosphated pieces. The compound used was Bonderlube 235; however, the lubricating compound must be purchased from the same manufacturer as is the zinc phosphate compound to assure compatibility of the two coatings. The lubricating solution is prepared by mixing with hot water and sulfuric acid, in accordance with Universal Solution Mixing Section, Operation No. U-167.

The machine used to perform the Phosphate Coat and Lubricate operation was a two-section, rotary-cylinder type machine manufactured by N. Ransohoff, Inc. The solutions are maintained at the proper temperatures in separate tanks, until ready for use, when they are pumped into the rotary cylinder containing the work.

First Draw - The first draw operation was performed on the annealed cups using a Bliss #62 duplex press, with 5-inch stroke producing four pieces per stroke (two pieces each side). As with all drawing operations, two dies, top and bottom, were used to form the metal. These were used in conjunction with a guide ring and a stripper, but without a lube ring.

Lubrication and tool cooling were accomplished using a stream of lubricant solution supplied by a circulating system and directed onto the punch and downward into the dies. No problems were encountered relative to lubrication and cooling, as long as the zinc phosphate and lubricant coatings applied during the previous operation were satisfactory.

The compound used for tool cooling was G. Whitfield Richards SB 300 drawing compound, mixed in the ratio of one part SB 300 to six parts hot water.

Wash, Rust Preventive Rinse and Dry - The purpose of this operation is identical to that of Wash and Rust Prevent: removal of foreign matter and drawing solution from the pieces. However, the tumbling action produced in the Baird washer is no longer needed nor desired. For this reason, a Niagara Washer, manufactured by G. S. Blakeslee Company was employed. The washer uses a rotating barrel with an auger to transfer the pieces through the solutions. The work is carried in the barrel above the solution surface. The solutions are introduced by means of scoops which raise the solutions into the barrel, immersing the pieces.

The cleaning agent employed was a solution of Pennsalt 30 dissolved in water. The solution is mixed according to Universal Solution Mixing Section, Operation No. U-32, with the exception that 7 1/2 pounds of alkaline cleaner is used in place of the two pounds specified.

For prevention of rust formation on the cleaned pieces, a water solution of potassium dichromate was used. The solution is prepared by the addition of three ounces of potassium dichromate to the rinse tank of the washer.

Following rinsing, the pieces are dried using hot air circulated over the work in the rotary barrel by means of a blower.

A summary of the operations performed in the Niagara washer follows:

Section	Operation	Agent	Temp °F	Minutes	To remove
First	Wash	Alkaline Solution	180-200	1 1/2	Foreign matter
Second	Rinse & Rust Preventive	Potassium Dichromate Solution	180-200	1 1/2	Alkaline solution
Third	Dry	Hot air	220-240	2	Moisture

Anneal for Second Draw - This operation was added to the process commencing with the manufacture of lot 310-D-1 (See Table I), due to the high incidence of mouth splitting encountered during subsequent drawing operations. With the addition of this anneal, the loss of ductility of the material produced by cold working through first and second draws was minimized. In the processing of subsequent lots of cases, mouth splitting during drawing was greatly reduced.

The procedure and equipment used to accomplish this operation was identical to that employed for the Anneal for First Draw.

Hardness on the sidewall of the piece at a location 1/16" from the base was maintained at R_B66 maximum.

Phosphate Coat and Lubricate - This operation is identical to the Phosphate Coat and Lubricate operation following Anneal for First Draw.

Second Draw - The second draw operation was performed on a Bliss No. 304 press, with an 8-inch stroke utilizing a maximum of four stations to produce up to four pieces per stroke. In pilot production, however, only a single punch was used. The design of the die set incorporated a guide ring, top die, lube ring, bottom die, and stripper.

Coolant solution was introduced at two locations: from a stream directed onto the punch and downward into the dies, and from the lube ring located between the dies. Pressure for both was supplied by a circulating system. Solution employed was identical to that used for the first draw operation, mixed in the same ratio of one part SB 300 to six parts water.

The pieces are fed to the press by means of a rotary pin hopper, followed by an air-operated turnover, feeding into feed tracks located on the press, through flexible tubes. The pieces are pushed along the feed tracks by means of mechanically-operated fingers, which cause each piece to drop into the guide ring prior to the downward stroke of the draw punch.

Wash, Rust Preventive Rinse and Dry - This operation is identical to the Wash, Rust Preventive Rinse and Dry operation following First Draw.

Anneal for Third Draw - This operation is identical to the Anneal for First Draw. Maximum allowable hardness on the sidewall at a position 1/16" from the junction of base and sidewall was R_B66.

Phosphate Coat and Lubricate - This operation is identical to the Phosphate Coat and Lubricate operation following Anneal for First Draw.

Third Draw - The third draw operation utilized the same Bliss No. 304 press which was employed at Second Draw. Changes made to modify this press were confined to the feed track, which was made narrower and higher to accommodate the deeper-drawn second draw piece. Again, a single punch was used for pilot production.

Wash, Rust Preventive Rinse and Dry - This operation is identical to the Wash, Rust Preventive Rinse and Dry operation following First Draw.

Phosphate Coat and Lubricate - This operation is identical to the Phosphate Coat and Lubricate operation preceding First Draw.

Fourth Draw - The equipment used for the Fourth Draw operation was essentially similar to that used for the second and third draw operations. The press employed was again a Bliss #304, but having an increased stroke of 9 inches. The longer stroke was required in order that the draw punch would clear the third draw component upon feeding, and so that the draw component would be pushed completely through the stri completion of the downward stroke. The press used could accommodate a maximum of three punches, although only a single punch was used for pilot production.

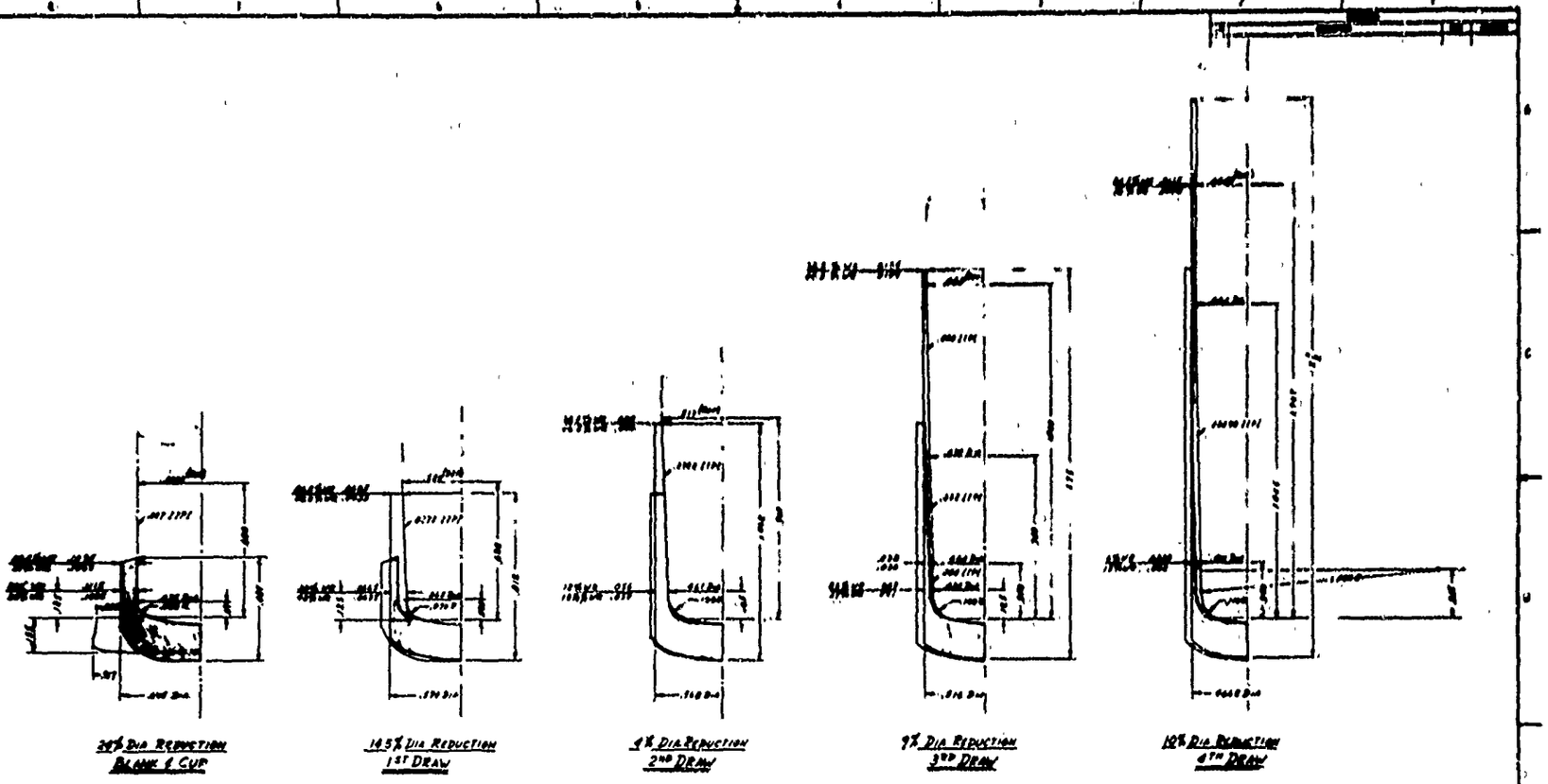
The drawing solution used at fourth draw was identical in preparation and application to that used at second and third draws.

It should be noted that no anneal is used between the third draw and fourth draw operations. The cold working of the sidewall of the components during these two operations establishes an elongated grain structure in the sidewall, increasing the hardness and tensile strength of the case body, but decreasing the transverse ductility.

The punch used to perform the fourth draw operation was chrome plated. The chrome plated punch retards wear, allows the steel to move along the punch more readily, and aids in stripping. Punch wear at final draw becomes particularly critical, since wall thickness and inside body configuration are determined by this operation. In addition, the hardness of the fourth draw piece, and consequently of the finished case sidewall, are achieved through proper thinning of the metal.

A change was made in the configuration of the final draw punch prior to processing of lots 310-C-2 and 310-C-3. This change involved the location and depth of the punch undercut, which was made deeper and located closer to the tip of the punch to minimize splitting and "accordioning" of the mouth of the piece during stripping.

Bleed radius on the fourth draw punch was found to be a critical factor related to proper functioning of the case. It was noted that lack of a proper bleed radius at a point 1.445 inches from the punch tip, at a junction point of angles, was the cause of a partial circumferential rupture in function and casualty testing.



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Wash, Rust Preventive Rinse and Dry - This operation is identical to the Wash, Rust Preventive Rinse and Dry operation following First Draw.

Trim - The machine used to perform this operation was a single-spindle horizontal trim machine, manufactured by Peters Engineering Company, employing a rotary cutter and burring cutter. Spindle speed used was 1,740 RPM; cutter speed was 400 RPM. No lubricant was used for the trim operation, but tool life is extended by the wash operation preceding.

Sort - The purpose of the sort operation is to segregate scrap by means of a visual inspection performed on the pieces as they pass the inspector on a moving belt conveyor.

Pocket - The pocket operation was used throughout cold worked case processing to introduce a greater amount of cold working into the head of the case than would be possible using a single heading operation. The pocket operation forms a dimple at the ultimate location of the finished primer pocket, part of which remains after heading.

Through cold forming of the metal around the pocket punch and around the tip of the pocketing eject stem, a relatively uniform hardness and grain configuration is attainable in the entire head area following heading.

The machine used for pocketing was a 63-ton horizontal crank and toggle press manufactured by Jarecki Machine Company, having a crank stroke of 8 1/2 inches (pocket punch) and a toggle stroke of 7 7/8 inches (eject stem)

Lubrication was accomplished by means of an oil cup dispensing lard oil to a wiping cloth which contacts the work.

An automatic knockoff device, actuated by a limit switch, stopped the press in the event of a feed stoppage. This was necessary to prevent the pocket punch contacting the eject stem when no work was present in the die.

Head - At the heading operation, the primer pocket was formed from the indent produced at the pocket operation, the base surface of the head was formed and head-stamped, and the final inside base configuration of the case was formed. In forming the head about the heading punch and eject stem, additional cold working was performed in the head area to achieve finished-case hardness.

Equipment and lubrication used at the heading operation were identical to those used at pocketing, with the exception of tooling.

A two-piece heading punch was used throughout the program, due to difficulties encountered in obtaining one-piece punches. This method was found satisfactory, although it produced a burr at the junction of the primer pocket and head surface. This burr was removed by the introduction of a deburring station at the venting operation.

Wash, Rust Preventive Rinse and Dry – This operation is identical to the Wash, Rust Preventive Rinse and Dry operation following First Draw.

Stress Relief – The stress relief operation was introduced to relieve internal stresses in the pieces following the major cold forming operations, without altering the physical properties of the steel. The operation was performed by heating the pieces to a temperature of 840± 10°F for 40 minutes at heat in an electric, recirculating air furnace manufactured by Lindberg Engineering Company.

As shown in Table I, two lots of cold worked cases were stress relieved following the vent operation. No significant advantages or disadvantages of this procedure were discovered in the two lots involved.

Head Turn – The machine used to perform this operation was a single spindle horizontal head turn machine manufactured by Standard Knapp. At the completion of production, spindle speed was 2,270 RPM and machine speed was 40 RPM (40 pieces per minute). Machine speed was reduced to approximately one-half that used for the 7.62MM brass case, in an effort to improve tool life.

Tool life was improved through a change to carbide tooling, although tool life and breakage continued to be problems. Tool cooling and lubrication were accomplished by means of an atomizer dispensing a mist directly onto the form tool. The mist was prepared by mixing one part of S-500 soluble oil, manufactured by Hangsterfer Labs, Inc., Mantua, N.J., with 30 parts of water. The mixture was then poured into the atomizer, which was adjusted to provide a fine mist.

Due to the difficulties encountered at the head turn operation, it is suggested that any future developmental work on head turning of steel cases be set up on a Black Rock Universal head turn machine. This machine, having variable speed motors and adjustable feed, is more versatile where developmental work is required to determine optimum feeds and speeds.

Vent and Deburr – The vent and deburr operation for the steel case was separated from the primer insert operation in order that the varnish applied to the finished case would completely cover the case, including the vent hole.

The machine used to vent and deburr was a crank and rocker, vertical, straight line, underdrive primer insert machine manufactured by Waterbury Farrel Foundry and Machine Company. The machine was altered, by removal of stations, in order that only the burr, vent, and no vent detect functions would be performed.

Various automatic knockoff devices were incorporated into the machine setup. These were as follows:

a. At the Burr station a knockoff device was actuated in the event that a case failed to feed into the machine.

b. At both the First and Second No Vent Detect stations, a knockoff device was actuated in the event that a case was produced with no vent hole, an eccentric vent hole, or foreign matter in the pocket.

As was stated in the description of the Head operation, the Burr station incorporated in the Vent and Deburr operation may be eliminated when a one-piece heading punch is used. In the event that a one-piece heading punch is used in future production, it is recommended that a horizontal crank, single punch press, manufactured by Derbyshire Machine Company, be utilized to perform the vent operation.

Partial Body Anneal – A partial body anneal was performed on the vented case in order that the neck and shoulder of the completed case could be formed without the occurrence of splits and folds at the Taper and Plug operation. The hardness pattern produced at the body anneal was found to be particularly critical, both in the Taper and Plug operation and in function and casualty testing of the finished cartridges.

Two methods were utilized for annealing the cases. The method first used in the program made use of a twin-screw, horizontal gas flame annealer, manufactured by Modern Bond, and operating at a speed of 120 RPM.

The second method used for annealing utilized an induction annealer manufactured by the Ohio Crankshaft Company. The cases were conveyed through an induction coil operated by a 10kHz alternating current generator by means of a chain having rollers to rotate the cases. The Tocco annealer was originally purchased for a body annealing operation which was attempted on the heat treated steel case. At the time this operation was eliminated from the process, the machine was altered for use in partial body annealing of the cold worked case during processing of lot 310-D-1. (See Table I).

Several casualties were encountered during function and casualty testing of this lot. In an effort to determine the cause of the casualties, another lot, 310-C-2, was processed using the induction anneal. From the satisfactory results obtained from this lot, it was subsequently determined that induction annealing was feasible in the pilot production of the cold worked case.

Four paddle-type hoppers were used to feed cases to the annealing fixture through a turnover. Continuing difficulties were encountered in the feeding of the cases to the conveyor. Failure of a single hopper to feed produced gaps in the work on the conveyor, resulting in distortion of the alternating field within the induction coil. This distortion produced inconsistent hardness patterns in the work produced.

Another problem area resulted from failure of the cases to rotate within the induction coil. The cases were caused to rotate by friction between a guide rail and fiber rollers attached to the conveyor chain. The guide rail required precise adjustment, which could not always be maintained during operation. Failure of a case to rotate produced drastic differences in the hardness pattern around the circumference of the case.

The hardness pattern specified for the final case lots after body anneal was a result of comparison of function and casualty test results with hardness patterns present in previous lots. It was found that previous lots differed greatly in hardness before tapering at a point on the sidewall 1-11/16" from the outside base. (See Table II).

Thus, the final two lots were precessed using a hardness pattern before tapering similar to that used in the more-successful prior lots. This pattern was produced in lot 310-C-2, which was gas annealed, and then reproduced in lot 310-C-3 by induction anneal.

TABLE II

HARDNESS AFTER BODY ANNEAL (VICKERS 2-1/2 kg)

	Distance from Outside Base (in)					
Lot	1-13/32	1-1/2	1-37/64	1-11/16	1-3/4	1-7/8
11A1		264				
11A2		270		160		152
11B1		259		151		147
11B2		270		175		155
310-B-1		265	273	220		167
310-C-1		279	267	165		161
310-D-1		284	253	206		205
310-F-1		254	251	158		148
310-C-2	269		245	176	162	162
310-C-3	256		240		150	150

Using both gas and induction annealing equipment, as soon as it could be tentatively determined by hardness checks that the machine had been properly adjusted, approximately five pieces were tapered, using appropriate tooling, and inspected with a magnifying glass for visual evidence of taper folds in the neck, shoulder, and upper body. In selecting samples of annealed pieces for hardness determination and tapering visual inspection, it is important that the sample from the induction annealer be selected from the approximate center of a quantity of pieces sufficient to completely fill the coil, in order that the field distortion explained previously may be avoided.

Phosphate Coat - The body annealed pieces were phosphated prior to the Taper and Plug operation in order that the oil used as a lubricant would be retained by the pieces during tapering. The Phosphate Coat operation is identical to the Phosphate Coat and Lubricate operation following anneal for First Draw, with the exception of the seventh section operation (lubricate), which is omitted.

Taper and Plug - The Taper and Plug operation was performed on a vertical double action crank press manufactured by E. W. Bliss Company. The press utilizes a rotary indexing table to feed the pieces to each successive station in the operation.

As performed on the majority of the cold worked case lots, the taper and plug operation consisted of four separate forming operations, all performed on the same press. These were mouth ironing, first taper, second taper, and plug.

The mouth ironing operation was not used for a portion of the production, particularly when it was determined that the work coming to the Taper and Plug operation was in satisfactory physical condition and free of dents. It was found that dents present in the body-annealed work caused folds in the shoulder and neck area upon tapering. Therefore, it is recommended that the mouth ironing station be utilized, particularly if dents are found to be present in the untapered cases at the mouth and upper body.

The body taper, shoulder, and neck of the case are formed at the two tapering stations. At the second taper station, adjustment is made in the press to determine the head-to-shoulder length of the completed case. Finished case dimensions call for a head-to-shoulder length of 1.632 - .006". Attempts were made to keep as close to the mean of this tolerance as possible. However, a statistical sampling of cases manufactured concurrently from two different steels indicated that the mean head-to-shoulder dimension differed by approximately 0.002" between the two case lots.

The purpose of the plugging station is final sizing of the mouth inside diameter. This station utilizes only a punch, which is inserted into the case mouth and withdrawn.

Lubrication of the components is accomplished using mineral cutting oil purchased in accordance with specification VV-0-251A, which is applied to the outside surface of the case by felt pads and to the inside surface of the neck by a leather washer. The pads, mounted in holders, are mechanically activated to lubricate the outside surface of the cases on the upstroke of the press. The washer enters the mouth of the case at the end of the downstroke and deposits oil on the inside of the case neck. The lubricant flows to the felt pads and washer from three oil reservoirs which are regulated to maintain the pads and washer in a moistened condition.

The amount of lubricant applied at the lubrication station must be carefully regulated to prevent the over-application of oil to the outside surface of the case. Excessive application of lubricant was found to result in entrapment of lubricant between the case and the tapering dies, causing dents and wrinkles in the tapered-case body.

At the plugging station, lubricant was applied to the punch to reduce friction. The oil was supplied from a reservoir which was adjusted to maintain a thin film of oil on the punch.

Foreign matter was detected at the lubrication station by means of a mechanical detector, which fully entered the case on the press downstroke. In the event that a case contained foreign matter, the detector did not enter fully and actuated a knock-off.

Wash, Rust Preventive Rinse and Dry – This operation is identical to the Wash, Rust Preventive Rinse and Dry operation following First Draw.

Finish Trim – The Finish Trim operation was the last forming operation performed in the process. The machine used was a single spindle vertical trim machine manufactured by Fidelity Machine Company.

In performing the trim operation using this machine, it is important to maintain pieces in the flexible feed tube at all times while the machine is in operation. When the tube was allowed to empty through a feed stoppage at the hopper, the last piece fed from the tube tended to bounce and be held by the case support at a position abnormally close to the cutter, resulting in an excess of metal being trimmed off and consequent short case length.

Wash, Rust Preventive Rinse and Dry – This operation is identical to the Wash, Rust Preventive Rinse and Dry operation following First Draw.

Visual Inspect – 100% – Upon completion of forming operations, all cases in a lot were visually inspected for all defects.

Iron Phosphate – The iron phosphating operation, consisting of several separate operations utilizing a series of tanks and a rotating basket, is performed on the cases to provide a base upon which to apply the varnish coating. The process employed in applying the iron phosphate coating follows:

a. Alkaline clean – the pieces are immersed in sodium orthosilicate solution at a concentration of 4–6 ounces per gallon and temperature of 190–210°F for five minutes.

b. Flowing water rinse – the work is rinsed in water at a temperature of 170–180°F for two minutes.

c. Acid pickle – the pieces are immersed in Pennsalt PM-90, 25% concentration by volume at 145–155°F for eight minutes. Pennsalt PM-90 is a hydrochloric acid-based material found particularly effective for removal of scale.

d. Flowing water rinse – same as step (b).

e. Iron phosphate – the cases are immersed in Oakite Crys Coat No. 89 at a concentration of 3-6 ounces per gallon of water and a temperature of 155–165°F for 6–8 minutes.

f. Flowing water rinse – same as step (b).

g. Conditioning rinse – the work is immersed in chromic-phosphoric acid, PH2-4, at 165-175°F for one minute.

Drying is accomplished immediately following removal of work from the conditioning rinse while the pieces are still hot by blasting with compressed air while the basket is rotating.

This process utilizing Pennsalt PM-90 was adopted after processing of lots 310-C-2 and 310-C-3. The PM-90 stage replaces an electrolytic cleaning operation formerly used to remove scale. In each of the above two lots a high percentage of defective cases were produced at the electrolytic cleaning operation due to arcing between components.

Varnish – Varnishing of finished cases was performed using a centrifuge-type varnishing machine manufactured by Ronci. In operation, the iron phosphated cases are placed in varnishing racks which are inserted one at a time into the varnish machine. The cases are first immersed in varnish for approximately one minute. They are then centrifuged for one minute to remove excess varnish. The varnish removed is returned to the varnish container in the machine.

The phenolic varnish used is purchased in accordance with MIL-V-12276C, Type III, Class B. Varnish viscosity at room temperature must be 26 to 30 seconds Zahn #2 cup, for proper application.

Due to the amount of labor and handling involved in applying varnish using the method described above, a machine was designed and procured to varnish and cure cases in production quantities. The machine utilized a series of pins which were loaded manually and which conveyed the cases through varnish, drain, cure and eject stations. Provisions were also made for stripping of varnish from the conveyor pins prior to reloading.

This machine was tested using samples of cases, and it was discovered that satisfactory stripping of varnish from the conveyor could not be accomplished. Efforts made to rectify the situation were not successful, and use of the machine was discontinued.

Varnish Cure – Upon removal of the cases from the Ronci varnish machine, the racked cases are cured in an oven at 375 to 400 degrees F metal temperature for 30 to 45 minutes.

The color of the cured cases was used as a general check of the varnish curing operation. Properly cured cases were uniformly dark green in appearance. A grey appearance indicated incomplete cure; dark brown indicated high curing temperature.

Acceptance of a group of cured cases was determined by immersion of sample cases in acetone, purchased in accordance with Federal Specification O-A-51, for a period of five minutes. On removal from the acetone, the sample cases were rubbed vigorously with the thumb, hand, or suitable wiping material and visually inspected for evidence of lifting, blistering, or softening of the varnish. In the event that the varnish failed to pass the acetone immersion test, the group of cases was returned to the oven for additional curing.

Visual Inspect - 100% - This inspection is simular to the 100% Visual Inspect operation preceding iron phosphating. At this inspection, however, special attention is paid to defects which might occur during iron phosphating, varnishing or varnish curing. In addition, certain types of defects, such as draw scratches and shoulder folds, become more apparent with the reflective varnish coating.

Problems were encountered at this operation, which were caused by dirty paddle hoppers on the inspection machine. The hoppers had accumulated a film of dust and non-adherent zinc phosphate from prior inspection operations, which if not carefully washed from the hopper and paddle wheel, severely scratched the varnish coating on the cases. The scratching was noted to be particularly severe in the areas of the rim, junction of body and shoulder, and mouth of the case.

Prime - Primer insertion was accomplished using a Waterbury Farrel primer insert machine identical to that used for the Vent and Deburr operation, with the Vent and Deburr stations removed. The two No Vent Detect stations were included in both the Vent and Deburr and Prime operations. While these stations were not entirely necessary at this stage of processing, they were included to eliminate the occurence of this serious defect. In the event that the Derbyshire venting machine is used, the two No Vent Detect stations should be utilized at the Prime operation, as the Derbyshire machine does not perform this function.

At the Prime operation, the following functions are performed.

a. No case detect - an automatic knock-off device is actuated when a case is omitted, stopping the machine.

b. Spread mouth - the mouth and neck of the case are straightened to facilitate bullet insertion.

c. No vent detect #1 & 2 - an automatic knock-off device is actuated when a missing vent hole or foreign matter in the pocket is detected at either of these two stations.

d. Insert and seat primer - the primer, fed by a conveyor, is inserted into the case to the proper depth.

e. Inverted and no primer detect – in case of an inverted or missing primer, an escapement is automatically opened to allow the case to drop into a container.

f. Crimp – the metal immediately surrounding the primer is circular crimped to retain the primer in the pocket.

g. Waterproof mouth and primer – waterproofing compound is applied to the case mouth by means of a plunger and to the space between primer and pocket sidewall.

Primer waterproofing solution is mixed in accordance with Universal Solution Mixing Section, Operation No. U-110. Viscosity at room temperature was maintained at 15 seconds, Zahn #2 cup.

Mouth waterproofing compound is mixed in accordance with Universal Solution Mixing Section, Operation No. U-111. Viscosity at room temperature was maintained at 17 to 33 seconds, Zahn #2 cup. The band of waterproofing applied to the case mouth was maintained at approximately 0.28 inch wide.

Mouth waterproofing should be allowed to dry for a period of not less than two hours and not greater than three days before bullet insertion.

All operations included in the processing of cold worked cases have been included in this section. Procedures and equipment are current as of this writing and cessation of production of pilot lots. However, equipment improvement studies, particularly in the areas of blanking and cupping, induction body annealing and iron phosphating, are continuing at Frankford Arsenal. Efforts are being made to improve both the quality and efficiency of these operations, which at present have not been developed to the state necessary for continuous high-volume production.

TABLE III

Comparison of Process Used for Heat-Treated Steel 7.62mm Cartridge Cases

As Compared to Present Cold-Work, Former Steel, and Present Brass Process

Present Steel FA Heat Treat	Present Steel FA Cold Work	Present Brass
1. Blank & Cup	1. Blank & Cup	1. Blank & Cup
2. Wash, Rust Prevent Rinse & Dry	2. Wash, Rust Prevent Rinse & Dry	2. Wash, Rinse & Dry
3. Anneal	3. Anneal	3. Anneal
4. Phoscoat & Lube	4. Phoscoat & Lube	4. Pickle, Rinse, Neut & Rinse
5. 1st Draw	5. 1st Draw	5. 1st Draw
6. Wash, Rust Prevent Rinse & Dry	6. Wash, Rust Prevent Rinse & Dry	6. Wash, Rinse & Dry
7. Anneal	7. Anneal	7. Anneal
8. Phoscoat & Lube	8. Phoscoat & Lube	8. Pickle, Rinse, Neut & Rinse
		9. Wash, Rinse & Dry
9. 2nd Draw	9. 2nd Draw	10. 2nd Draw
10. Wash, Rust Prevent Rinse & Dry	10. Wash, Rust Prevent Rinse & Dry	11. Wash, Rinse & Dry
11. Anneal	11. Anneal	12. Anneal
12. Phoscoat & Lube	12. Phoscoat & Lube	13. Pickle, Rinse, Neut & Rinse
		14. Wash, Rinse & Dry
13. 3rd Draw	13. 3rd Draw	15. 3rd Draw
14. Wash, Rust Prevent Rinse & Dry	14. Wash, Rust Prevent Rinse & Dry	16. Wash, Rinse & Dry
	15. Phoscoat & Lube	
	16. 4th Draw	
	17. Wash, Rust Prevent Rinse & Dry	
15. Trim	18. Trim	17. Trim
16. Sort	19. Sort	18. Sort
	20. Pocket	19. Pocket

TABLE III (Cont)

Comparison of Process Used for Heat-Treated Steel 7.62mm Cartridge Cases As Compared to Present Cold-Work, Former Steel, and Present Brass Process

Present Steel FA	Present Steel FA	Present Brass
Heat Treat	Cold Work	
17. Head	21. Head	20. Head
18. Wash, Rust Prevent Rinse & Dry	22. Wash, Rust Prevent Rinse & Dry	21. Wash, Rinse & Dry
	23. Stress Relieve	
19. Head Turn	24. Head Turn	22. Head Turn
20. Vent & Deburr	25. Vent & Deburr	
	26. Body Anneal	23. Body Anneal
	27. Phosphate Coat	
21. Taper & Plug	28. Taper & Plug	24. Taper & Plug
22. Wash, Rust Prevent Rinse & Dry	29. Wash, Rust Prevent Rinse & Dry	25. Wash, Rinse & Dry
23. Finish Trim	30. Finish Trim	26. Finish Trim
24. Wash, Rust Prevent Rinse & Dry	31. Wash, Rust Prevent Rinse & Dry	
		27. Stress Relieve
		28. Pickle, Rinse
		29. Neutralize, Lubricate
		30. Dry
		31. Mouth Anneal
25. Visual Inspect	32. Visual Inspect	32. Visual Inspect
26. Harden		
27. Wash, Rust Prevent Rinse & Dry		
28. Temper		
29. Iron Phosphate	33. Iron Phosphate	
30. Varnish & Cure	34. Varnish & Cure	
31. Visual Inspect	35. Visual Inspect	

PROCESS METALLURGY

This section describes the material requirements of the strip used in processing the 7.62mm steel case and the metallurgical changes which take place at various steps of processing. Figures 4 to 14 show representative hardnesses and microstructures of respective process pieces.

Material Requirements

The greatest portion of the work done at Frankford Arsenal in cold worked case development utilized cold rolled steel strip, varying in carbon content from .22%C to .31%C. A total of ten lots of cartridges were manufactured, using four different steels for case fabrication. These four steels are shown in Tables IV and V.

It was found, as a result of success in processing and in ballistic testing, that two of the steels, both AISI grade 1025, performed significantly more satisfactorily in nearly all respects than did the other two steels, of AISI grades 1026 and 1030. The determining factor being considered in both of these areas is incidence of splitting, both during processing and during function and casualty testing. In all instances, when a given lot of cases contained many rejects due to splitting in process, the same condition was encountered during proof testing of the cases remaining in the lot. All steels were aluminum killed, of fine grain and drawing quality, and were supplied in the spheroidized annealed condition.

It has been found particularly important in the manufacture of steel cases to limit the defects in the strip to an absolute minimum. Defects which have been found to be particularly detrimental are roll marks, seams, scratches, scale pits, and rolled-in scale.

Due to lack of adequate facilities, phosphate coating of the strip before blanking was never attempted by the steel suppliers or by Frankford Arsenal on a production basis. However, if coated strip is utilized, rigid inspection of the strip before coating is required in order that the defects noted above may be detected.

Table IV
Chemistry of Steel Strip
Manufacturer's Ladle Analysis

Mfr	Grade	C	Mn	P	S	Si	Al
Republic	1026	.22	.82	.010	.009	.02	.040
Sharon	1025	.24	.34	.010	.016	.04	-
Republic	1030	.31	.75	.013	.021	-	-
Republic	1025	.24	.43	.010	.022	-	-

Table V
Chemistry of Steel Strip
Manufacturer's Ladle Analysis

Mfr	Grade	C	Mn	P	S	Si	Al
Republic	1026	.22	.69,.70	.002	.023	<.1	.04
Sharon	1025	.25	.35	.006	.018	<.1	.05-.1
Republic	1030	.34	.80,.79	.002	.032	<.1	.02
Republic	1025	.22	.44	.003	.021	<.1	.03

Process Evaluation

Processing of all lots of cold worked cases was monitored by examination of hardnesses and microstructures at each stage of processing where a metallurgical change occurred. Figures 4 to 14 show the results of these examinations for lot 310-C-1. This lot was manufactured from Sharon C1025 steel, which proved to be one of the most satisfactory steels evaluated.

Figure 4 shows the microstructure and hardness of the coil of Sharon steel used for cupping of the lot. The steel is purchased according to specification MIL-S-645A(MU). The chemical composition of the steel, given in Tables I and II, differs from that specified by MIL-S-645A(MU), since one objective of the study was to determine the suitability of various steels for case manufacture. The as-received strip is relatively fine-grained, with most of the carbides in the spheroidal form with relatively uniform distribution.

The unannealed cup is shown in Figure V. The sidewall and base both retain the spheroidized annealed structure of the strip. The cold worked sidewall shows directionality, whereas the base is equiaxed. Unrestricted grain flow was evident in all areas. The annealed cup, Figure 6, shows a relatively equiaxed ferrite matrix in both the sidewall and base.

The first draw operation, shown in Figure 7, shows relatively severe grain elongation in the sidewall. Minor strain occurs in the curvature region between sidewall and base; little change occurs in the microstructure of the base. All lots of cases processed prior to TMP-310-D-1 were processed through the first and second draws with no interdraw anneal. Lots processed after that time were annealed prior to second draw to lessen drawing force and minimize mouth splitting.

Figure 8 shows the as-drawn second-draw component. Severe grain elongation is evident in the sidewall due to the lack of an annealing operation between the first and second draws. Subsequent addition of the interdraw anneal eliminated this condition. Again, there is little change in the base area.

The anneal after second draw, shown in figure 9, produces recrystallization in the side-wall following the severe working at second draw. Minor grain growth, which could become critical if allowed to persist, is evident in the base area.

Figure 10 shows the third draw operation. The sidewall structure is severely cold worked, but no tearing of grain boundaries is evident. The base structure remains unchanged.

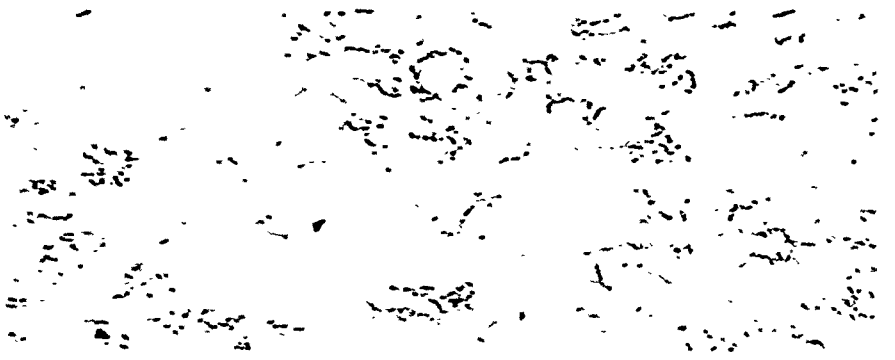
The fourth-draw component is shown in figure 11. Severe elongation may be seen in the sidewall. The cold-worked hardness of the case sidewall is produced principally at the third and fourth draws, which are performed with no interdraw anneal. Again, little change is seen in the microstructure of the base area.

Figure 12 shows the headed component. Prior to heading, a pocketing operation distributes the metal in the head of the case to aid in centering the primer pocket and to provide additional cold working. At the heading operation, the outside head surface is flattened and the primer pocket is formed. Excess metal from the die cavity is forced outward into the "ears" shown at the lower corners of the diagram of figure 12. The reverse flow of metal from the die cavity and compressive forces at the curvature combine to create the minor cold shuts shown in the photomicrograph.

Following the above forming operations, a stress relief is performed to relieve internal forming stresses and increase overall hardness. Sidewall hardness increases of approximately 20 to 60 points Vickers are evident in figure 13. The figure also shows the hardness pattern measured on the exterior surface, in the upper sidewall which is produced by the partial body anneal preceding tapering. The anneal softens the neck and shoulder areas sufficiently for tapering. The case sidewall below the shoulder must remain in the cold-worked condition to withstand the compressive stresses which are induced at the tapering operation. An equiaxed grain structure is produced in the upper sidewall with no change to the lower sidewall and base areas.

The finished case, shown as figure 15, shows the hardnesses measured at the standard positions shown on Drawing FD24412. Sidewall hardness is measured on the exterior sidewall; head hardness is measured on a longitudinally-sectioned case.

Table VI shows the finished case hardness of the various lots. Hardness shown is the average of 10 pieces.

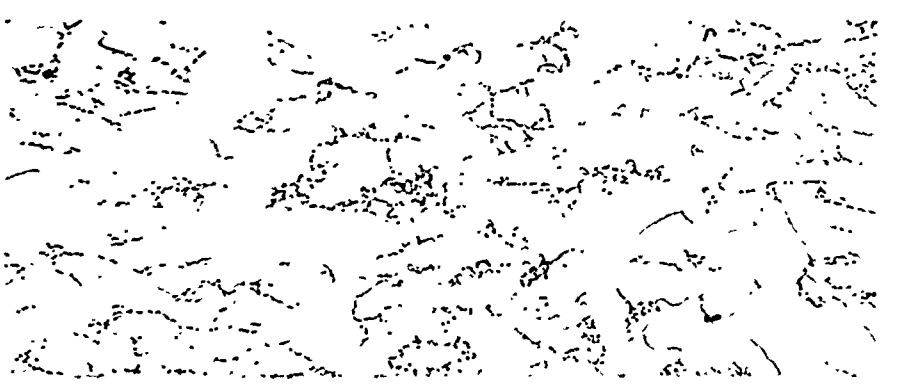


BEGINNING OF COIL 500X

FACE OF STRIP

HARDNESS R_B

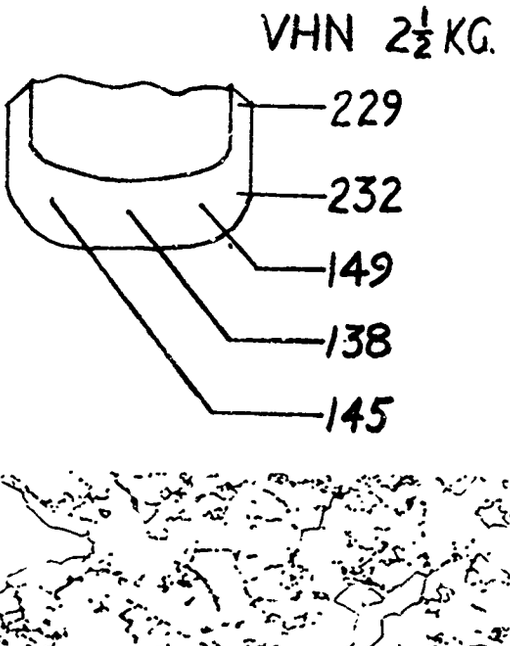
BEGINNING	END
63	70
65	69
66	69
66	69
66	68

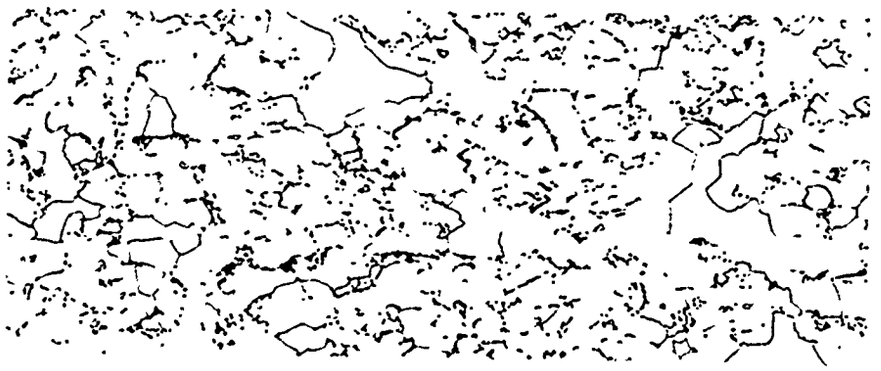


END OF COIL 500X

Figure 4. Strip

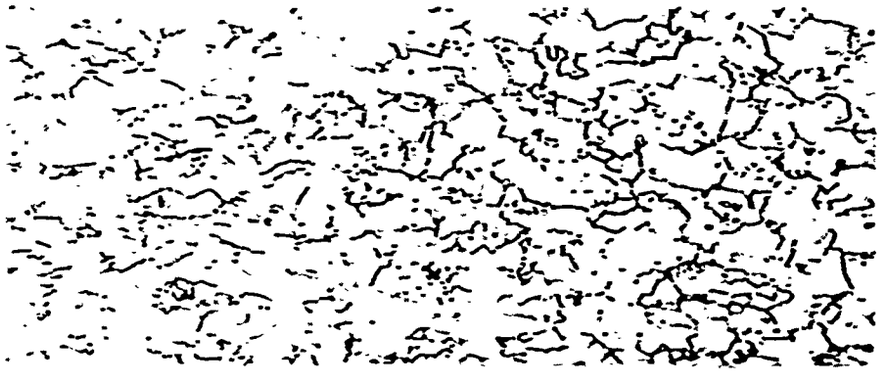
SIDEWALL 500X



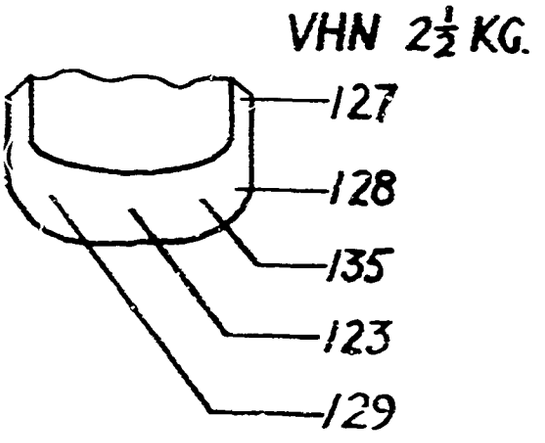


BASE 500X

Figure 5. Unannealed Cup

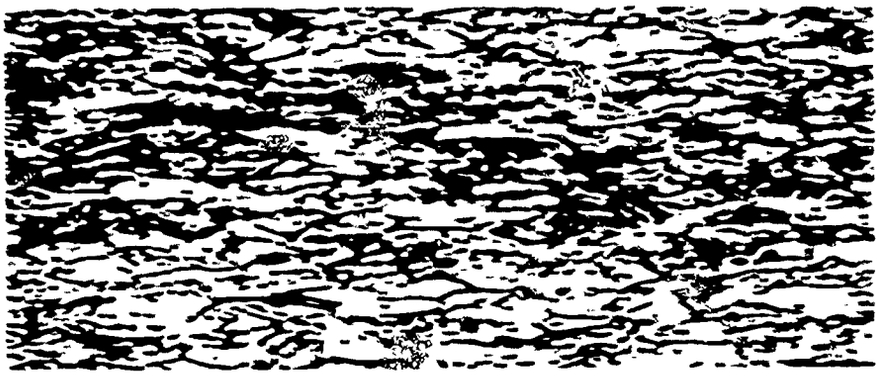


SIDEWALL 500X



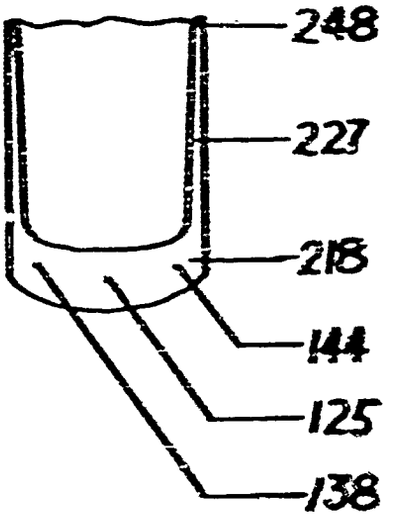
BASE 500X

Figure 6. Annealed Cup



SIDEWALL 500X

VHN $2\frac{1}{2}$ KG.

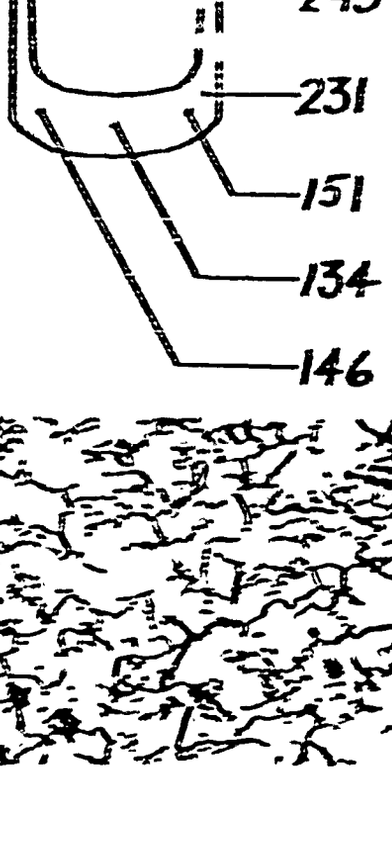


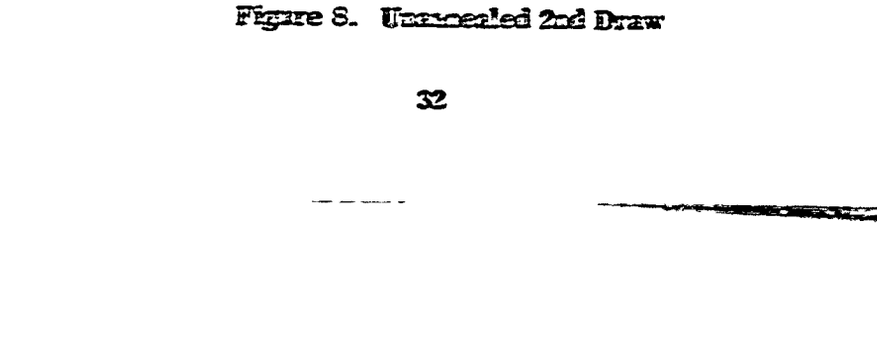
BASE 500X

Figure 7. Unannealed 1st Draw

SIDEWALL 500X

VHN $2\frac{1}{2}$ KG.



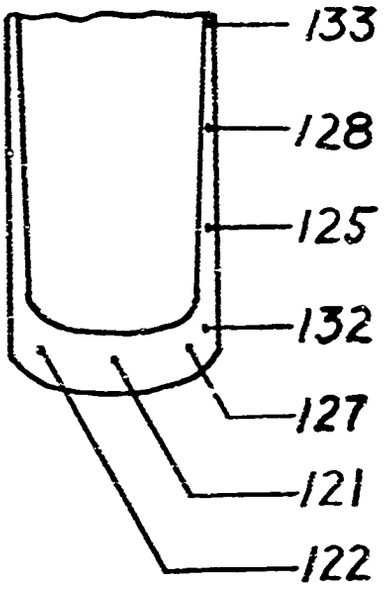


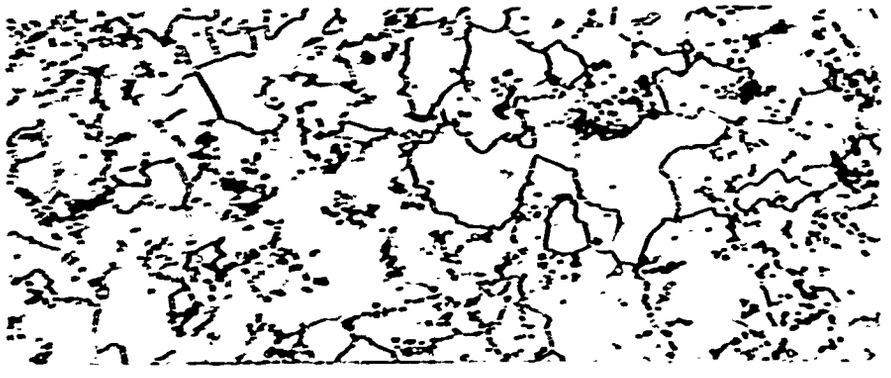
BASE 500X

Figure 8. Unmended 2nd Draw

SIDEWALL 500X

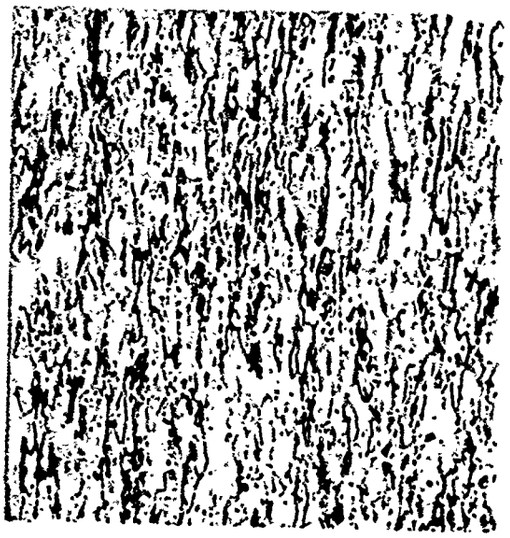
VHN 2½ KG.





BASE 500X

Figure 9. Annealed 2nd Draw



SIDEWALL 500X

BASE 500X

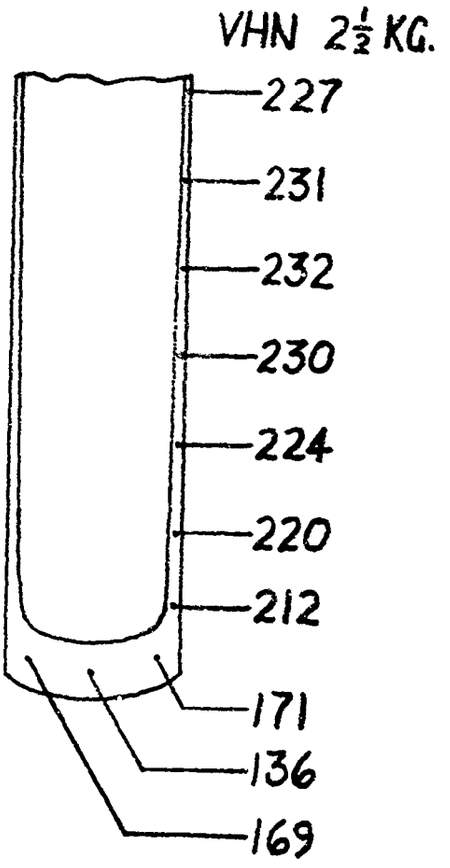
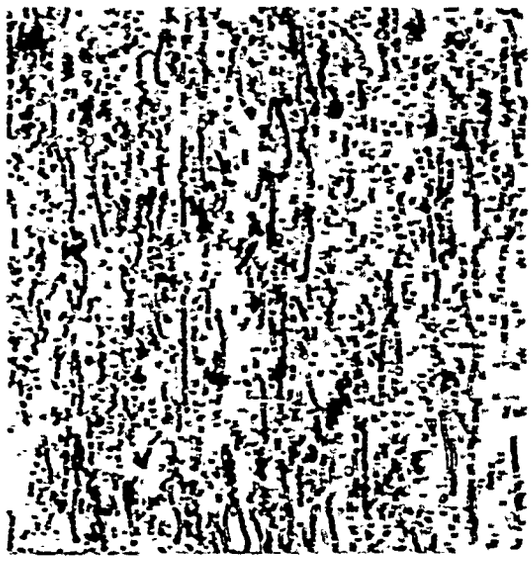


Figure 10. Third Draw



SIDEWALL 500X

BASE 500X.

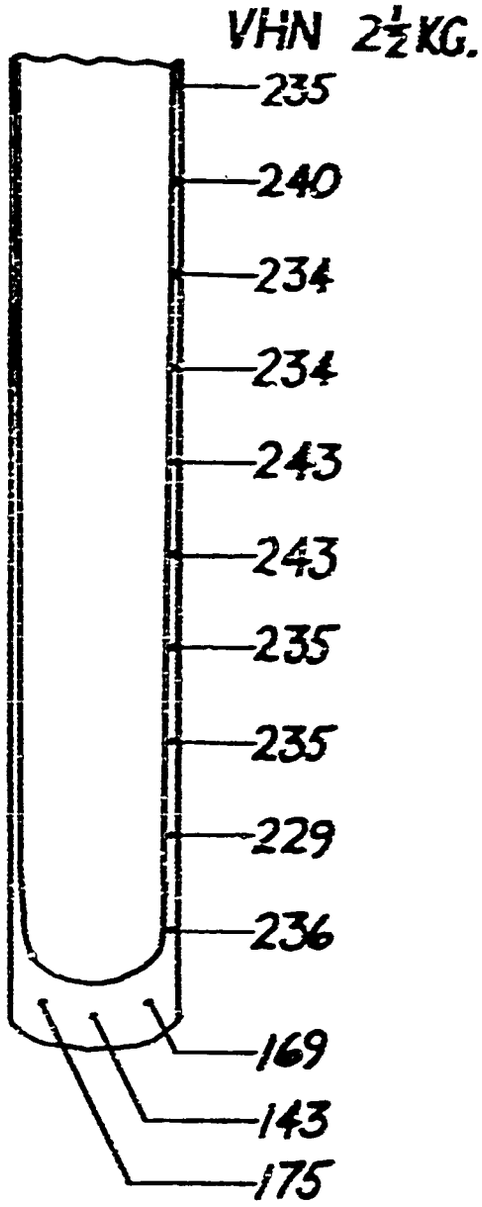


Figure 11. Fourth Draw

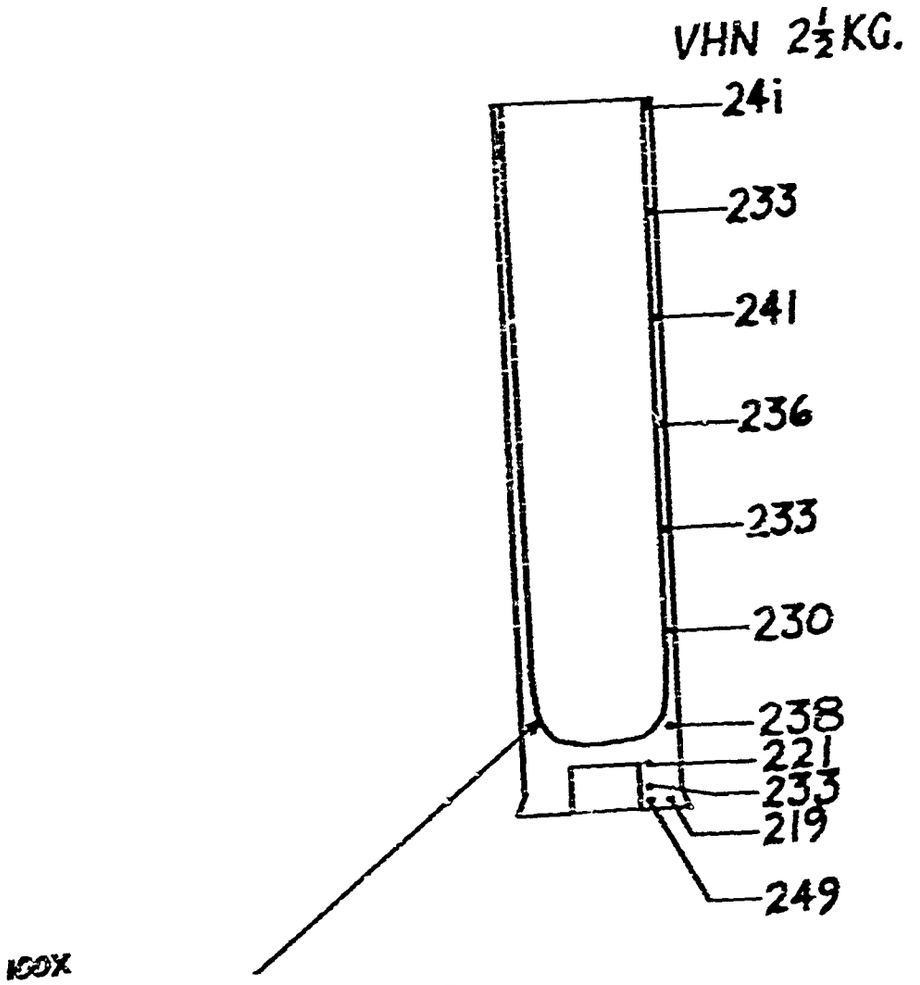


Figure 12. Head

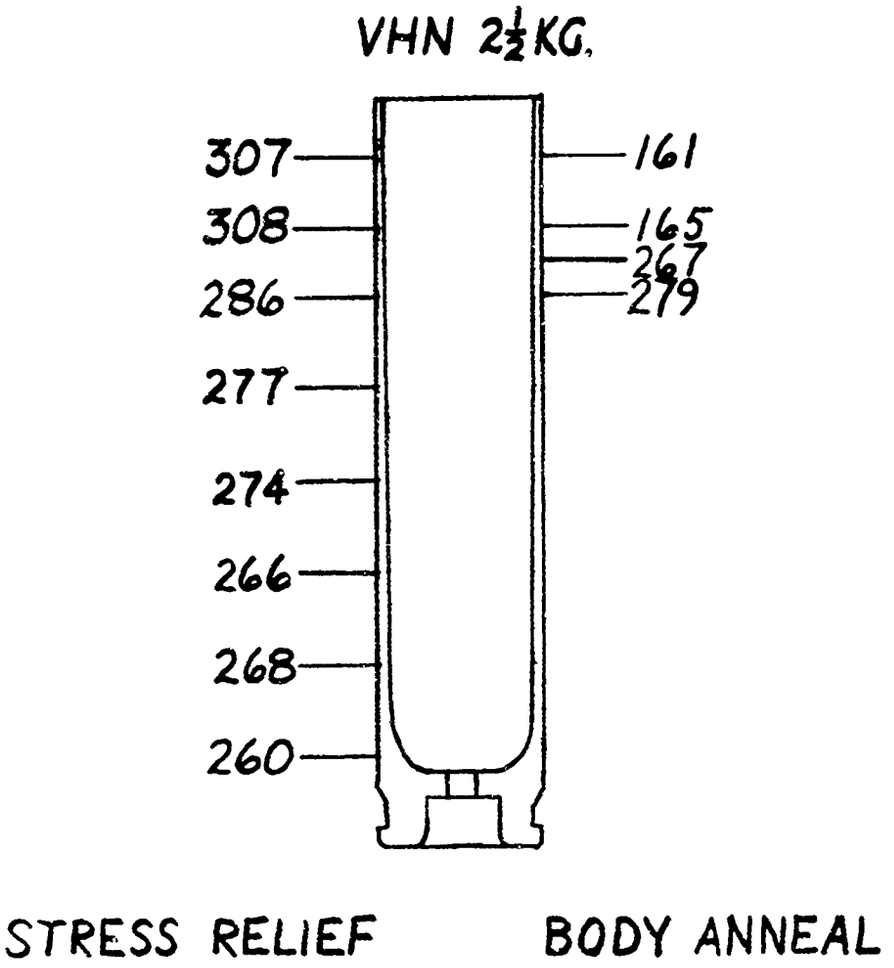


Figure 13. Stress Relief and Body Anneal

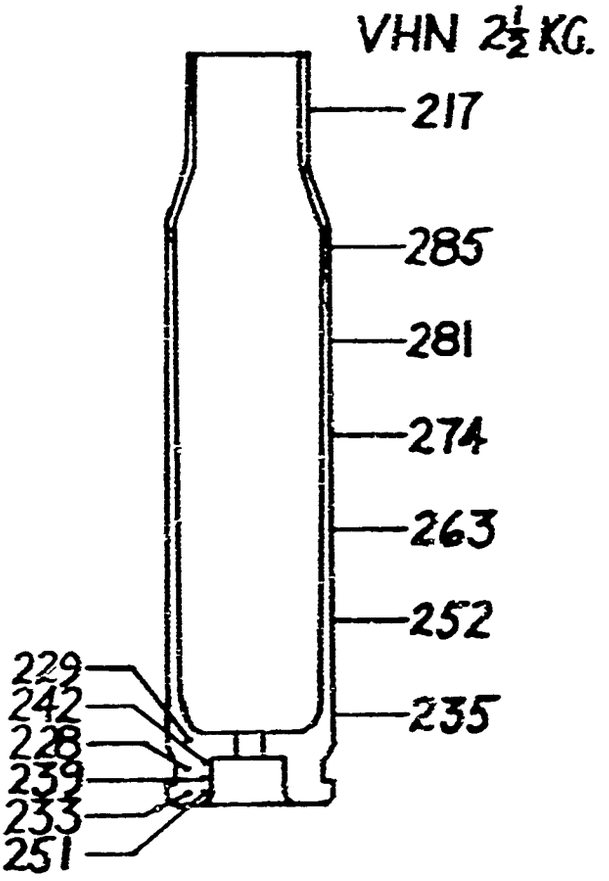


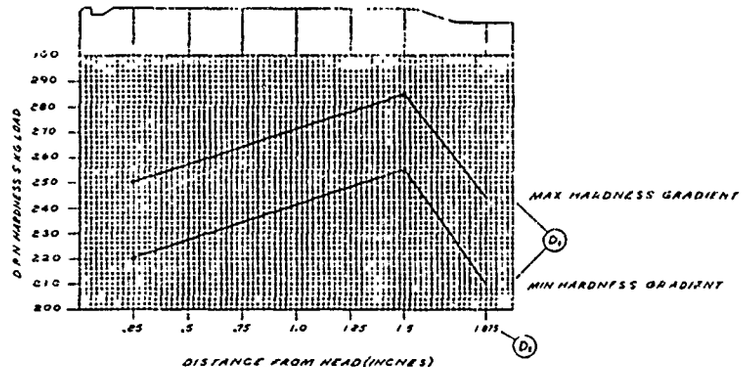
Figure 14. Finished Case

TABLE VI

FINISHED CASE HARDNESS (VICKERS 2 1/2 KG)

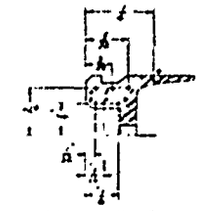
Location	Required Hardness	11A1	11A2	11B1	11B2	310-B-1	310-C-1	310-D-1	310-F-1	310-C-2	310-C-3
Body - Hardness measured on exterior sidewall (distance from head)										5 kg load	5 kg load
.250	220-250	225	228	243	234	233	236	239	221	215	213
.500	227-257	231	229	234	236	244	252	241	224	220	220
.750	234-264	244	240	240	248	254	263	251	231	227	228
1.000	241-271	253	248	256	256	263	274	256	231	234	236
1.250	248-278	266	260	265	265	269	281	260	247	242	242
1.500	255-285	272	264	265	264	276	285	263	252	251	248
1.750	210-245	200	198	195	197					232	211
1.875	210-245	202	203	202	203	223	217	230	216	206	197
Head - Positions specified by Dwg. FD24412. Sectioned head.											
A	220min	240	242	220	206	229	233	228	217	221	219
B	220min	261	257	243	226	258	251	249	236	212	221
C	220min	246	252	229	223	247	239	240	233	221	204
D	220min	259	252	223	227	244	242	243	227	206	210
E	220min	239	233	213	210	234	228	233	217	193	203
F	220min	230	223	206	201	231	229	225	217	223	221
G	220min	253	248	240	237						

FD24412



HARDNESS GRADIENT

SCALE 4/1



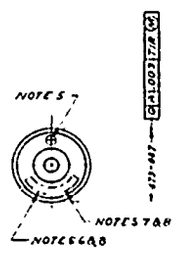
HEAD AXIAL SECTION

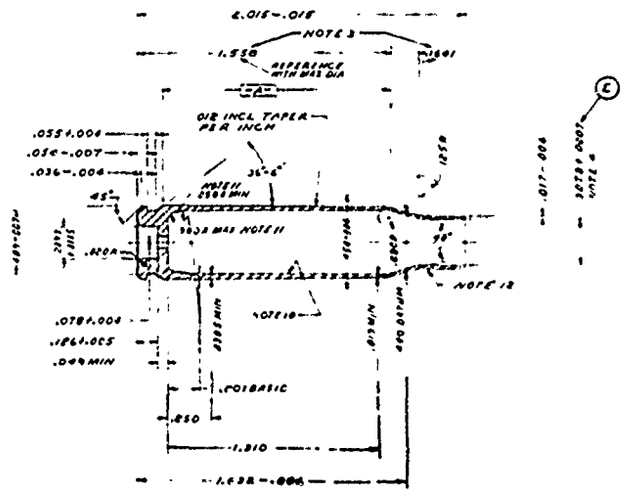
MINIMUM 260 D P N

SCALE 8/1

NOTES:

1. HARDNESS GRADIENT
   THE AVERAGE HARDNESS READINGS OF 10 FINISHED CARTRIDGE CASES AT EACH POSITION INDICATED SHALL FALL WITHIN THE RANGE FOR THAT POSITION DEFINED BY THE MAXIMUM AND MINIMUM HARDNESS GRADIENTS.
2. DIMENSIONS INCLUDE PROTECTIVE FINISH.
3. DIMENSIONS GIVEN AT INTERSECTION OF LINES.
4. DIMENSIONS AT PLUGGING OPERATION FOLLOWING TAPER (INFORMATIONAL)
5. NOTCH IDENTIFICATION MARK.
6. STAMP INITIALS OF MANUFACTURER OR RECOGNIZED TRADE MARK.
7. STAMP LAST TWO FIGURES OF YEAR OF MANUFACTURE.
8. STAMPING MUST BE LEGIBLE AND NOT ENCROACH ON THE PRIMER CRIMP OR HEAD BEVEL.
9. STANDARD FOR DIMENSIONING AND TOLERANCING SPEC MIL-STD-8 APPLIES.
10. INSIDE WALL TO BE A CONTINUOUS TAPER BETWEEN .030 S MIN AND .013 MIN.
11. .030 A MIN AND .900 R MAX ARE CONSTRUCTION DIMENSIONS WHICH INSURE THE MINIMUM PERMISSIBLE WALL THICKNESS.
12. AN INCLUDED TAPER NOT TO EXCEED .002 IS ALLOWABLE IN NECK.
13. REFERENCE CUP DRAWING 8-10535793
14. VARNISH, PHENOLIC, SPEC MIL-P-15328, TYPE III, CLASS B, EXTERIOR THICKNESS PER SIDE .0002 TO .0004. COMPLETE COVERAGE INSIDE (NOT TO BE MEASURED).





CODE IDENT NO. 19200

CASE, 7.62 MM CARTRIDGE, COLD WORKED

SIZE D

FD24412

SEE NOTE 14

Figure 11

F10 ECA

PROOF TESTING

Simulated acceptance testing was performed on all lots of cold worked cartridges. Quantities were reduced during tests of some lots due to the small quantities of cases in these lots. Testing was performed according to AMCR 715-505 "Ammunition Ballistic Acceptance Test Methods, Vol 3: Test Procedures for 7.62mm Cartridges" dated February 1964. Specification MIL-C-46281C(MU), dated 1 May 1965, was used for evaluation of the ammunition, which was loaded with tracer bullets.

Briefly, the acceptance tests fired and the requirements of the tests are as follows:

Accuracy - mean radii of 90 cartridges fired at ambient temperature and at 600-yard range shall not exceed 5.0 inches for ball ammunition packed in cartons or clips, 7.5 inches for ball ammunition packed in links, or 15.0 inches for tracer ammunition.

Velocity - average velocity of 20 cartridges conditioned at 68° - 72°F, shall be 2750 ± 30 fps. Average velocity of 20 cartridges subjected to high or low temperatures shall not vary from the average velocity of the same lot conditioned at 68° - 72°F, by more than +250 fps, nor more than -150 fps. Where sample size is other than 20, quantity is given in table of proof test results.

Chamber Pressure - average chamber pressure of 20 cartridges conditioned at 68° - 72°F, shall not exceed 50,000 psi. Average chamber pressure of 20 cartridges subjected to high or low temperatures shall not exceed 55,000 psi, nor exceed the average chamber pressure of the same lot conditioned at 68° - 72°F, by more than +7,500 psi, nor more than -15,000 psi.

Port Pressure - average port pressure of 20 cartridges conditioned at 68° - 72°F, shall be 12,500 ± 2,000 psi.

Action Time - average action time of 50 cartridges fired at 70° + 2°F, shall not exceed 4 milliseconds.

Trace - 85% of a sample of 200 tracer cartridges fired at ambient temperature must function according to specification.

Vacuum - 50 cartridges are immersed in water in a container which is evacuated to 7 1/2 psi below atmospheric pressure. Data given in the table of proof test results lists the number of leaking cartridges of a sample of 50.

Bullet Pull - the force required to extract the bullet from the case shall not be less than 60 pounds.

Function and Casualty - quantities of cartridges of each lot fired in each weapon at each temperature are listed in the table of proof test results in parentheses following casualty listings. Firing in the M73 machinegun is not required and was performed for information only. Permissible quantities of the defects and abbreviations shown in Table VII are as follows:

Ruptures, Body

Complete, J-Area(RJ) - 0
Partial, L-Area(RL) - 0

Misfire (MF) - 1

Large Primer leak (LL) - 23

Small Primer leak (SL) - 49

Splits

Neck and shoulder (I and S) - 49
Body (J) 4
Body (K) 1

Primer setback - no defect if not loose.

Failure to extract (FX) - 0

The above summary should be used only for interpretation of the proof test results presented in this section. Full details are available in the referenced specifications and regulations.

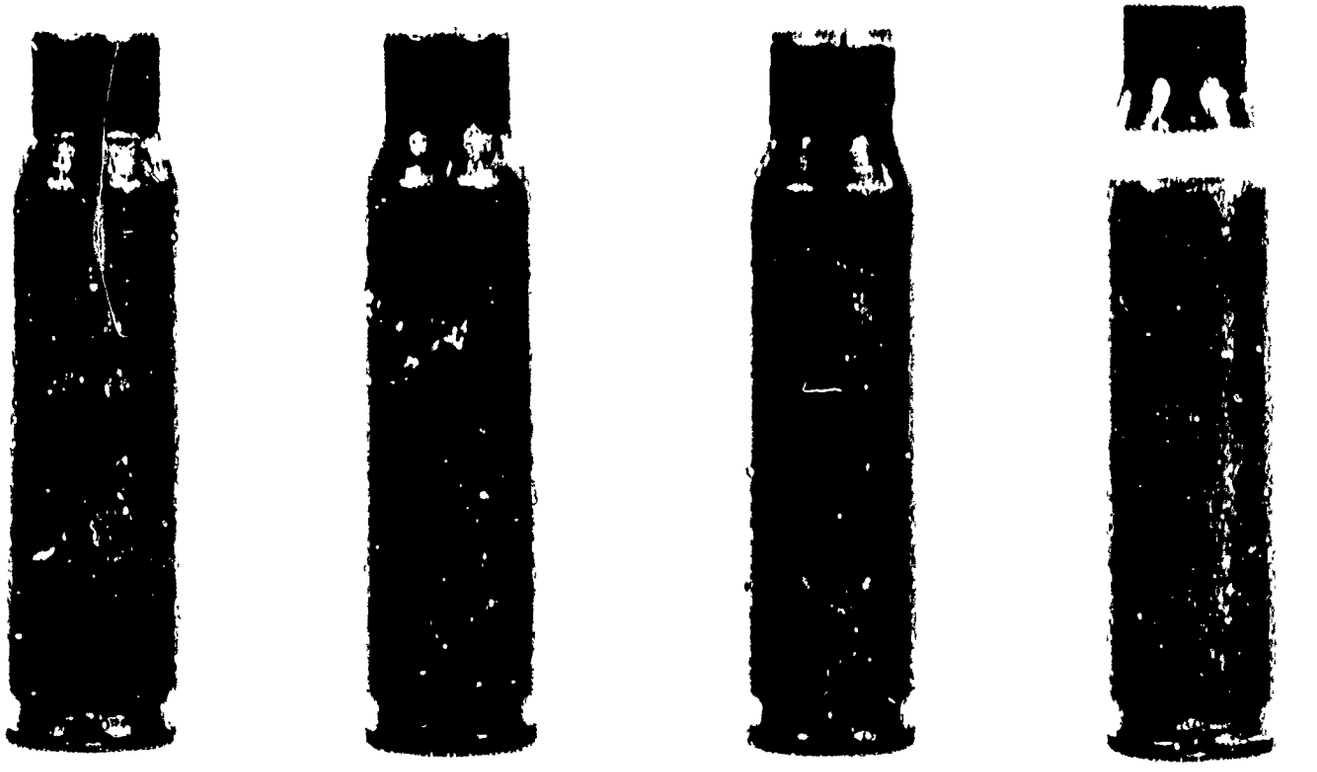
TABLE VII
PROOF TEST RESULTS
7.62MM COLD WORKED STEEL CASE

TEST	TEMP °F	11A1	11B1	11A2	11B2	310-B-1	310-C-1	310-D-1	310-F-1	310-C-2	310-C-3
Accuracy (in. mr)							9.44	7.98	4.85		
Velocity (fps)	+ 70	2743	2743	2743	2722	2722	2729	2742	2733	2774	2762
	+125	2763	2758	2768	2716		2769 (10)	2782 (10)	2762 (10)	2818 (10)	2799 (10)
	+160						2640 (10)	2693 (10)	2677 (10)	2766 (10)	2741 (10)
	- 65	2656	2644	2657	2651		2631	2424	2614	2673	2649
Chamber Pressure (psi)	+ 70	45300	44100	44400	45600	44100	44100	42350	43000	44040	44366
	+125	44900	44500	44400	45600		45200 (10)	44560 (10)	44400 (10)	44960 (10)	45360 (10)
	+160						41200 (10)	39706 (10)	40100 (10)	43460 (10)	43100 (10)
	- 65	41600	41200	42300	43200		34100	35500	38700	40260	39560
Port Pressure (psi)	+ 70	10800	10700	10900	10460	11500	11200	11600	11100	11000	11160
Bullet Extraction (lbs)		325	305	315	322	317	297	321	311	318	317
Vacuum (slow leak)		1	1	0	0	0	0	0	0		
(fast leak)		0	0	0	0	0	0	0	0		
Function & Casualty											
M60	+ 70	(300)	(300)	(300)	(300)	(300)	(300)	1:1, 1:15 (1600)	(300)	(300)	(300)
	+125	(100)	(100)	(100)	5:BL (100)	(50)	(50)	1:1 (50)	(50)	(50)	(50)
	+160					(50)	(50)	(50)	(50)	1:1 (50)	(50)
	- 65	(100)	(100)	1:BL (100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
M52	+ 70	(300)	1:BL (300)	1:BL (300)	(300)	(300)	(300)	1:1 (300)	1:1.1, (300)	(300)	(300)
	+125	1:BL (100)	1:BL (100)	(100)	5:BL (100)	(50)	(50)	(50)	(50)	(50)	(50)
	+160					(50)	(50)	(50)	(50)	(50)	(50)
	- 65	(100)	(100)	2:BL (100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
M14	+ 70	1:BJ (120)	(120)	(120)	(120)	1:BJ (120)	(120)	5:1, 1:15 (120)	(120)	(120)	(120)
	+125	(80)	(80)	(80)	1:1 (80)	(40)	(40)	2:1 (40)	2:BL (40)	(40)	(40)
	+160					2:BJ (40)	(40)	1:1, 1:15, (40) 2:8, 1:BJ	(50)	(40)	(40)
	- 65	(80)	(80)	(80)	(80)	1:1, 1:8, (80) 6:BJ, 1:15	(80)	(80)	(80)	(80)	(80)
G3	+ 70	(120)	(120)	(120)	(120)	(120)	(120)	4:1, 8:15 (120)	(120)	(120)	(120)
	+125	(80)	(80)	(80)	(80)	(40)	(40)	4:1 (40)	(40)	(40)	(40)
	+160					(40)	(40)	4:1 (40)	(50)	(40)	(40)
	- 65	(80)	(80)	(80)	(80)	1:1, 3:15, (40) 1:BJ	(40)	8:BJ (40)	(40)	(40)	(40)
LAR	+ 70	(120)	(120)	(120)	(120)	2:15, 8:8, (120) 15:BJ	3:BJ (120)	4:1, 6:BJ (120) 1:BJ	1:BJ (120)	(120)	(120)
	+125	(80)	1:BJ (80)	1:BL (80)	(80)	4:8, 12:BJ (40)	3:BJ (40)	1:8 (40)	(40)	(40)	(40)
	+150					7:8, 7:BJ (40)	(40)	(40)	(50)	(40)	(40)
	- 65	(80)	1:MP, 1:BJ (80)	1:BL (80)	(80)	2:BJ (80)	1:BJ (80)	15:BJ (80)	8:BJ (80)	2:BJ, 1:8, (160)	3:BJ (80)
LIA1	+ 70	(120)	1:1 (120)	(120)	1:BJ (120)	3:15 (120)	(120)	2:1, 1:15, (120) 1:BJ	(120)	(120)	(120)
	+125	1:BJ (80)	(80)	(80)	(80)	8:8, 8:BJ (40)	(40)	2:1, 1:15 (40)	(40)	(40)	(40)
	+160					1:8, 1:BJ (40)	(40)	1:15 (40)	(50)	(40)	(40)
	- 65	1:1BJ, 1:BJ (80)	1:1 (80)	(80)	(80)	1:1, 1:8, (80) 2:BJ	(80)	4:1, 8:15 (80) 3:8, 1:BJ	(80)	(80)	(80)
M78	+ 70		4:BL$_{10}$(300) 1:L$_1$, (100)	1:BL$_{10}$(300) 3:FX	4:BL (300)	1:BJ (175)	(175)	24 1, 43:15 (300) 1:BJ	(1000)	(300)	(300)
	+125			2:BL$_{10}$(100) 1:L$_1$, 1:MP	2:FX(100)	1:14 (40)	1:15 (40)	1:1, 1:8, (80) 1:15	1:1 (40)	(100)	(80)
	+160					(50)	(50)	1:1, 1:15 (40)	(50)	(40)	(40)
	- 65		(100)	3:FX (100)	1:BL (100)	(100)	(100)	1:1, 8:15 (100)	4:1 (100)	(100)	(100)

Figure 16. Lot 11-A-1 Case Casualties

Partial Rupture
LAR Rifle
-050R

Figure 17. Lot 11-A-8 Case Casualties



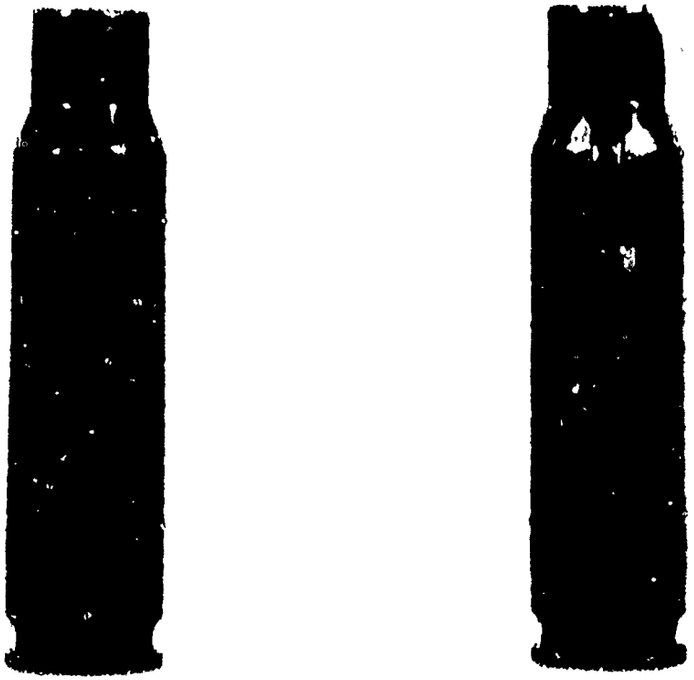
I-Split
LIAI Rifle
+70°F

8J-Split
LAR Rifle
-65°F

I-Split
LIAI Rifle
-65°F

Complete Rupture
LAR Rifle
+125°F

Figure 18. Lot 11-D-1 Case Casualties



I-Split
M14 Rifle
-125°F

8J-Split
M14 Rifle
+70°F

Figure 10. Lot 11-D-2 Case Casualties

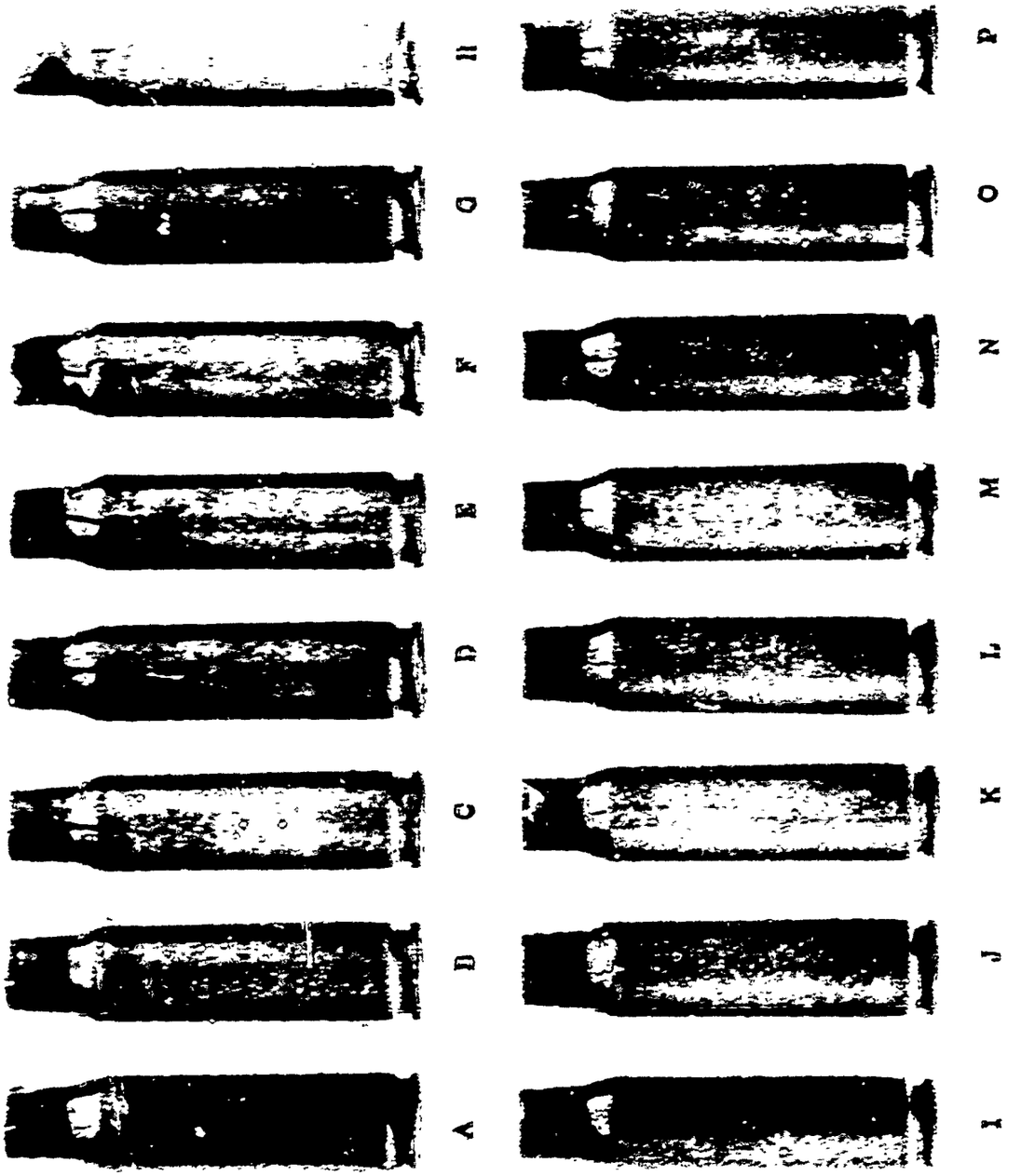


Figure 29. Samples of Case Casualties - TMP-310

SAMPLES OF CASE CASUALTIES - TMP 310

(See Fig. 20)

SEPTEMBER, 1968

SAMPLE	TEMP °F	LOT	WEAPON	TYPE OF SPLIT
A	+ 70	310-D-1	M52	I
B	+125	310-F-1	M73	I
C	+ 70	310-B-1	M73	SJ
D	+ 70	310-D-1	LAR	SJ
E	+160	310-B-1	M14	SJ
F	+125	310-B-1	LAR	SJ
G	+ 70	310-D-1	LAR	SJ
H	+125	310-C-1	LAR	SJ
I	+ 70	310-D-1	M73	IS
J	+125	310-C-1	M73	IS
K	+160	310-B-1	LAR	S
L	+125	310-D-1	M73	S
M	- 65	310-B-1	L1A1	S
N	- 65	310-D-1	M14	S
O	+125	310-D-1	M73	IS
P	- 65	310-D-1	L1A1	IS

CONCLUSIONS

As a result of the study covered by this report, a process was developed for production of a 7.62mm cold worked steel case. Lots 310-C-1, 310-C-2, 310-C-3 and 310-F-1, all produced from C1025 steel, gave the most satisfactory results in simulated acceptance testing.

To verify the producibility of the cold worked case by the process thus developed, the Industrial Services Directorate at Frankford Arsenal was instructed to process a quantity of Sharon C1025 steel strip according to a specified process (shown as Appendix B) without assistance from the project engineer. Approximately 70,000 ball M80 and 30,000 tracer M62 cartridges were produced according to a manufacturing process which was slightly modified from that specified. Results of simulated lot acceptance testing were disappointing. The lot of ball cartridges was rejected due to a large number of case body splits. Processing and testing of these lots will be covered by a separate report.

Adequate inspection and quality control are mandatory in steel case production. Much of the in-process inspection during pilot production was performed by persons familiar only with brass-case production. Due to the notch sensitivity of steel, it is particularly important that draw scratches, wrinkles, taper folds, and other surface imperfections be eliminated prior to packaging.

Surface finish is particularly critical due to the poor corrosion resistance of the steel case. Tests should be performed diligently and frequently during processing to insure that iron phosphate and varnish are applied properly.

Machine adjustments and tool dimensions must be checked frequently particularly with cold worked cases, since overall case hardness is determined by the amount of reduction and cold working performed at the various forming operations.

RECOMMENDATIONS

Since the start of cold-worked steel case processing in 1967, supplies of copper on the free world market have become more stable and less costly. The Copper Industry Trade Institute has predicted a surplus of copper over the next few years, thereby temporarily eliminating the need for a 7.62mm steel case for economic reasons. At the present time, the cost of converting ammunition plants to steel case production appears to outweigh any price advantage of steel over brass as a raw material.

As a result of the apparently improving condition of copper supplies, it is recommended that the process documented by this report be shelved but kept in readiness in the event that copper becomes scarce.

The goal of the present steel case program was to provide, in a minimum amount of time, a steel case process which could be implemented in an emergency using as many pieces of easily-available equipment as possible. However, with recent advances in steelmaking technology, the feasibility of a greatly-improved steel case should be investigated in a long range study aimed at reducing the cost and improving the performance of the small-caliber cartridge case.

FRANKFORD ARSENAL
AMMUNITION DEVELOPMENT & ENGINEERING LABORATORIES
ENGINEERING DIVISION TMP-310-7.62MM STEEL

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	Sidney White	J9100	Ext.6272
Support Engineering			
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	E. Dougherty	J4500	Ext. 24195
Chemistry----------	E. Kelley	J4400	Ext. 5123
	W. Svekla	J4400	Ext. 24285

Subject---------- Case, Cartridge, 7.62MM Steel, Cold Worked, Manufactured from different types of steel.

Instructions and Requirements:

1. The following types and quantities of steel strip and cups will be processed and tested under this program. Each type of steel will be identified with a different letter which must be maintained throughout the life of the program.

a. TMP-310-A - 6000lbs. of 1023 carbon steel purchased from Allen Wood Co. One half of cups produced under TMP-309-A

b. TMP-310-B - 6000 lbs. of 1025 carbon steel, vacuum degased purchased from Republic Steel Co. One half of cups produced under TMP-309-B

c. TMP-310-C - One coil 1025 carbon steel,purchased from Sharon Steel Co. for TMP-305.

d. TMP-310-D - 14,520 lbs. of 1031 carbon steel purchased from Republic Steel Co. One half of cups produced under TMP-309-D

e. TMP-310-E - 75,000 cups (swaged) 1025 carbon to be purchased from Bethlehem Steel Co.

f. TMP-310-F - One coil of 1025 carbon steel purchased from Republic Steel for TMP 301.

NOTE: It is imperative that the information requested throughout this TMP be gathered as required. This information is required to prepare specifications, Technical Data Packages, Manufacturing procedures, and a final report at the end of the program. Therefore, each area responsible for the portions of this TMP shall acknowledge by submitting the information, within the second seven calender days of each month, to the Project Engineer, Mr. Walter Weis, Bldg. 219-2.

The quantities of cups to be processed into cartridge cases, Dwg. FD 24412 from the above listed materials shall be specified by the Project Engineer.

2. Industrial Services Directorate shall process the strip or cups in the following manner using the sequence of operations, tools, inspection limits, hardness controls and solutions listed below. Maintain the identity of each type of steel with CW (cold work) as well as designated letters.

2.1 Blank & Cup

Press: crank vertical, double action - Bliss No. 6
Tools: Blanking Punch, SKFSA 11205, Rev C
Cupping Punch, SKFSA 11206 Rev C
Blank & Cup Die, SKFSA 11207, Rev E
Stripper, SKFSA 11208
Stripper Spring, PT-1006
Stripper Holder, SKFSA 3683
Gage Limits: SKFSA 9863 - O.D. 0.694-0.700
SKFSA 9864 - Base thick. 0.150 - 0.156
SKFSA 9865 - Wall thick. 0.180 inside
Base - 0.107 - 0.117
Wall thick.var.0.180 from inside
Base - 0.004 max.
Wall height var.0.035 max.
Weight - 194 grs (approx)

Solution: 1-1/2 parts water to 1 part Lubro No.44

2.2 Wash, Rust Prevent

Barrel: metal, rotary, inclinable, Baird
Solution: Hot water, 4 cups tri-sodium phosphate; wash for 1/2 hour;
Rust Preventive: potassium dichromate added to final rinse.

2.3 Anneal

Furnace: Lindberg, atmosphere controlled
Temperature: 1320°F
Time in furnace: 51 minutes atheat (51 minutes cooling)
Hardness: 1/16" from junction of base and sidewall on O.D. R_B 65 max.

2.4 Phosphate Coat & Lubricate

Machine: Ransomatic unit or other appropriate equipment

2.5 First Draw

Press: crank vertical duplex Bliss No. 62
Tools: Punch FB5669
Guide Ring PT-1966A
Top Die PTC-1982
Bottom Die PTC-1983
Stripper PT-1294A
Stripper Holder PT-1005
Stripper Spring PT-1006
Gage Limits: SKFSA 9866 - O.D. 0.595-0.600
FB 36251 - base thick. 0.150-0.158
SKFSA 9867- wall thick. 0.437 from inside
Base 0.058 -0.062
wall thick, var. 0.437 from inside base-
0.004 max.

Drawing Solution: One (1) part Lubewell S5300 mixed with 6 parts water.

2.6 Wash, Rust Preventive Rinse & Dry

Washer: Niagara
Solution: 7.5 lbs of Pensalt to 200 gals of water
Rust Preventive: 3 oz of potassium dichromate added to rinse water

2.7 Phosphate Coat & Lubricate

2.8 Second Draw

Press: crank, vertical, single action, Bliss No. 304
Tools: Punch FB 56667
Guide Ring FB 52211
Top Die PTC-114 or SKFSA 6803 or FB 18618A
Lube Ring SKFSA 10768
Bottom Die PTC-115 or SKFSA 6803 or FB 18618B
Stripper PT-1002
Stripper Holder PT-1005
Stripper Spring PT-1006
Gage & Limits: FB 22309 - O.D..5695-.572
FB 22305 - base thick. 0.152-0.160
wall thick. and var. at 1/4" and 3/4" to be established.

Drawing Solution: One (1) part Lubewell SB300 mixed with 6 parts water.

2.9 Wash, Rust Preventive Rinse & Dry

Washer: Niagara - (see 2.6)

2.10 Anneal

Furnace: Lindberg, atmosphere controlled
Temperature: 1350°F
Time in furnace: 5minutes at heat (51 minutes cooling)
Hardness: 1/16" above junction of base and sidewall on O.D. R_B 65 max.

2.11 Phosphate Coat & Lubricate

Machine: Bonnomatic unit or other appropriate equipment

2.12 Third Draw

Press: crank vertical, single action, Bliss No. 30
Tools:

Punch	FB 56663
Guide Ring	FB 56670
Top Die	FTC-2203 or FB 36360
Lube Ring	SKFSA 10768
Bottom Die	FTC-121A
Stripper	FT-1003D
Stripper Holder	FT-1005
Stripper Spring	FT-1006

Gages & Limits: FB 36052 - O.D. 0.516-0.515
SKFSA 9873 - base thick. 0.155-0.165
SKFSA 9874 - wall thick. 1/4" from inside base 0.035 - 0.041
wall thick. var - 1/4" from inside base 0.005 max.
SKFSA 9875 - 1-1/8" from inside base wall thick. 0.018-0.023
wall thick. var - 1-1/8" from inside base 0.003max.

Drawing Solution: One (1) part Lubewell SB300mixed with 6 parts water.

2.13 Wash, Rust Preventive Rinse & Dry

Washer: Magna - (see 2.6)

2.14 Phosphate Coat & Lubricate (if necessary)

Machine: Bonnomatic unit or other appropriate equipment

2.15 Fourth Draw

Press: crank, vertical, single action, Bliss No. 304

Tools:	Punch	FB 56675
	Guide Ring	SKFSA 10770
	Top Die	FB 57128
	Lube Ring	SKFSA 18758
	Bottom Die	[illegible]
	Stripper	PT-1004E
	Stripper Holder	PT-1005B
	Stripper Spring	PT-1006

Gage & Limits: FB 41263 outside dia. 0.4670 – 0.4682
FB 22303 base thick. 0.153 – 0.163
FB 23471 wall thick. 1/4" from inside base 0.031-0.035
wall thick. var 1/4" from inside base 0.004 max.
FB 23471 wall thick. 0.70 from inside base 0.015-0.0135
wall thick. var. 0170 from inside base 0.002 max.

Drawing Solution: One (1) part Lubewell S3300 mixed with 6 partswater.

2.16 Wash, Rust Preventive Rinse & Dry

Washer: Niagara – (see 2.6)

2.17 Trim

Machine: horizontal, single spindle

Tools:	Cutter	SKFSA 10268
	Spindle	FA 30254
	Sleeve	SKFSA 6118
	Stripper Ring	SKFSA 6122
	Nut	FA 30255
	Burring Cutter	SKFSA 6119
	Spring	SKFSA 6123

Gages & Limits: SKFSA 9871 – inside length 1.840 – 1.860

2.18 Sort

2.18.1 Phosphate Coat & Lubricate (This operation required only if operation 2.14 is omitted)

2.19 Pocket

Press: horizontal toggle and crank

Tools:	Die	SKFSA 11572-2
	Eject Stem	FB 57126
	Punch	FB 23034A

Gage & Limits: FB 41260 – outside dia. 0.4684-0.4692
FB22303- web thick. 0.028 - 0.032
FB 22320 pocket concentricity 0.003 max.

2.0 Bead

Press: horizontal toggle and crank
Tools: Die SKFSA 11431-1
Eject Stem FB 57126
Punch(1pc)
Punch(1pc) FA 333333
Punch Holder PT-1041
Gages & Limits: FB 41247 - outside dia. 0.4680 - 0.4695
FB 22341 - pocket dia. 0.2093 - 0.2098
FB 22323 - pocket depth 0.1265 - 0.1305
FB 22363 - web thick. 0.057 - 0.062
FB 23482 - pocket concentricity 0.003 max.
FB 23330 - head crookedness 0.004 max.

2.21 Wash, Rust Preventive Rinse & Dry

Washer: Niagara - (see 2.6)

2.22 Stress Relief

Furnace: Lindberg, electric, recirculating air
Temperature: 540°F ±10°F for 40 minutes at temperature.

2.23 Head Turn

Machine: horizontal single spindle
Tools: Collet PT-1008S
Spring PT-1009
Form Tool FB 52213 (carbide type C6)
Gages & Limits: FC2884 - head dia. 0.467- 0.471
FC 2927 - head thick. 0.048 - 0.053
FC 2884 - Ext groove dia. 0.403 - 0.407

2.24 Vent & Deburr

Machine: WFF Primer Insert
Tools: Burr
Punch PT-1025
Stem FB 186365

Vent
Punch Holder PT-170B
Punch FB 36474
Die FB 36475
Stem FB 36476
1st No Vent Detect
Holder PT-176A
Clamp PT-179A
Stem PT177B
Detect Pin PT-178
2nd No Vent Detect - Same as 1st No Vent Detect
Gages & Limits: SKFSA 9668 - dia of vent hole 0.078- 0.082

NOTE: Operation and tools mentioned above are to be used when two piece beading punch is used at beading operation.

2.25 Partial Anneal (mouth)
Machine: Electric Induction first or
Machine: Gas (Brass Case Mouth Anneal)

2.26 Phosphate Coat

2.27 Taper & Ring

Press:	Vertical, double action, crank - Bliss No. 162	
Tools:	Mouth ironing punch	FA-33875
	Mouth ironing die	PT-1000
	Mouth ironing spring	PT-1012
1st Taper:	Shoulder Die	SKFSA-6139
	Body Die	SKFSA-6140
	Eject Stem	SKFSA-6142
	Die Anvil	SKFSA-6141
2nd Taper:	Shoulder Die	SKFSA-6143 or PTC 1921A
	Body Die	PTC 1969
	Eject Stem	PT 1918 or SKFSA 6142
	Die Anvil	SKFSA-6141
Ring:	Punch	PT-159A or SKFSA-6146
Gage & Limits	FB 23455	Concentricity of neck-0.004 max
	FB 23524	Max Profile
	FB 23520	Profile of body
	SKFSA-9870	Mouth diam. 0.3078-0.3085
	FB-23522	Length, head to shoulder 1.627 - 1.631
	FB-23460	Neck diam. 0.3413 - 0.3433
Lubricant	Machine oil	Spec. VV-O-251

2.28 Wash, Rust Preventive Wash & Dry
Washer: Niagara - (see 2.6)

2.29 Finish Trim

Machine: Vertical, single spindle

Tools:	Cutter	PTC-10103 or SKFSA 6148
	Cutter Holder	PT-1011B or SKFSA 6147
	Support Cover	PT-1014 or SKFSA 6149
	Retainer Seat	PT-1923 or SKFSA 6150
	Case Support	FA-33876 or SKFSA 6149
	Cutter Clamp	PT-1015A or SKFSA 6149

Gages & Limits: FB 23526 - total length 2.0003- 2.0093
Lubricant: Lubricate cases by wiping with a cloth impregnated with oil.
Oil spec. VV-O-251

2.30 Wash, Rust Preventive Rinse & Dry

Washer: Niagara - See 2.6

2.31 Visual Inspect -100%
Machine: Horizontal, twin screw, conveyor

2.32 Iron Phosphate (until the iron phosphating equipment and process in Bldg. 217 can be proven, iron phosphating of the cases will continue to be performed in and by the Plating Shop, X3424)

a. Pickle clean
b. Electrolytic clean
c. Alkaline clean
d. Water rinse
e. Acid pickle
f. Water rinse
g. Iron phosphate
h. Water rinse
i. Conditioning Rinse

} As described in FA chemical Process Control Handbook, Process #2

2.33 Dry To be determined by Plating Shop, X3424

2.34 Varnish - (until the varnish unit and process in Bldg. 217 can be proven, the case varnish operation will continue to be performed in and by the Painting Shop, X3422

Machine:
a. Material: Varnish, phenolic- Spec MIL-V-12276 Type III, Class B
b. Viscosity: Varnish viscosity at room temperature 26 to 30 seconds, Zahn #2 cup
c. Imersion: Time- 1 minute approx.
d. Centrifuge: Time - 1 minute approx.

2.35 Varnish Cure
Equipment : Oven
a. Curing time- 375° to 400°F metal temperature for 30 to 45 min.

NOTE: Varnish shall have a dark greenish appearance when it is properly cured.

2.36 Visual Inspect - 100%
Machine: Horizontal, twin Screw, conveyor.

2.37 Case Gage - 100%
Machine: Conventional cartridge gage and weigh machine set-up to gage the profile of the case.

2.38 Load, Gage & Weigh & Visual Inspect

Same machines as shown in the operations control Section pertaining to Cartridge, Ball & Tracer, NATO, 7.62mm, M80 & M62 except work shall be visually inspected as it is being discharged from each individual machine.

3. Furnish gages required to accomplish the project

4. Record the following information:

4.1 Number of pieces processed through each operation

4.2 Amount of scrap obtained at each operation

4.3 Amount of pieces processed by each tool

4.4 Reason each tool is discarded

4.5 Amount and cause of downtime

4.6 Machine speeds.

5. Perform a hardness test on five pieces, taken hourly from each of the interdraw anneals.

6. Measure five pieces from each cup and draw punch every hour. Record and submit to Project Engineer. (TMP 310-F)

7. Measure five pieces every 30 minutes from the trim operation through all subsequent operations with the exception of taper and plug, which shall be measured every 15 minutes. Record and submit measurements to Project Engineer.

8. Submit a copy of the cartridge case 100% visual inspections and the gage and weigh inspection to the Project Engineer.

9. Record and submit a record of the DRC bullet pull, velocity, pressure and waterproof tests taken at the loading operation, to the Project Engineer.

10. Perform a measurement survey(periodic check)and a weight check on samples of five varnished cases taken from the varnished case visual inspection operation for all dimensions shown on drawing FD24412. Record results, and forward to Project Engineer. The samples shall be taken at the beginning and end of each lot.

12. Perform a hardness check on samples of five (5) cartridge cases each, taken from the varnished case inspection operation. The samples shall be taken at the beginning and end of each lot. Take readings at positions (head & body) shown on drawing FD 24412, using recommended hardness and load.

13. Perform a hardness test on the strip at the beginning and end of each coil. Use Rockwell "B" scale. (MM-310-F)

14. Supply a sufficient quantity of WC846 Western Ball propellant to accomplish this program.

15. Supply sufficient quantities of 7.62mm Ball M80 and Tracer M62 Bullets for loading and assembling into cartridges. Project Engineer will specify amounts of each.

16. Supply a sufficient quantity of No. 34 primers for this program.

17. Maintain identity of work through all operations.

18. Furnish a complete cost breakdown of expenditures to Project Engineer Mr. W. Weis, J7200.

19. Forward quantities of cartridges as specified by Project Engineer to Engineering Proof Testing Laboratories J9200

20. Pack cartridges when requested

21. Remove tools from machine as each operation is completed and store properly identified, unless otherwise specified.

22. Manufacture additional tools, if required.

PITMAN DUNN RESEARCH LAB - L1000
MECHANICAL METALLURGY BRANCH - L7200

23. Furnish photomicrographs of samples of three components each, taken from the interdraw anneals, second, third and fourth draws. Photomicrographs shall be taken on the middle wall area using 750 magnification.

24. Examine a sample of five cartridge cases each from each lot for cold shut determinations. Take photomacrographs (100 magnification)

TEST & EVALUATION DIVISION - Q6000
BASIC MATERIALS EVALUATION BRANCH - Q6100

25. Perform hardness determinations as requested by ProjectEngineers.

25. Perform salt spray test using 20% solution on a sample of five varnished cartridge cases. Method of test shall be in conformance with Federal Test Method Standard No. 141, Method 6061

26 Perform salt spray test utilizing 20% solution on samples of five cartridges assembled with varnished cases. Method of test shall be in conformance with Federal Test Method Standard No. 141, Method 6061.

AMMUNITION DEVELOPMENT & ENGINEERING LAB., J4000
METALLURGICAL ENGR. BRANCH, J4400

27. Forward three components from each interdraw anneals and each draw to Mechanical Metallurgical Branch L7200 for photomicrographs of grain structure.

28. Forward five headed components to Mechanical Metallurgical Branch, L7200, for cold sheet determinations and photomicrographs.

29. Provide metallurgical technical assistance where and when required.

CHEMICAL ENGINEERING BRANCH - J4300

30. Forward samples of varnished cartridge cases and cartridges assembled with varnished cases to Environmental Branch, Q6200, for salt spray testing.

31. Provide chemical technical assistance where and when required.

SMALL CALIBER R&M ENGR. LAB, J9000
AMMUNITION ENGR. BRANCH, J9100

32. Forward samples of finished cases to Basic Materials Evaluation Branch, Q6100, for hardness determinations.

33. Provide technical assistance relative to tooling and process where and when required.

Walter F. Weis

WALTER F. WEIS

FRANKFORD ARSENAL
AMMUNITION DEVELOPMENT & ENGINEERING LABORATORIES
ENGINEERING DIVISION TMP 310-7.62mm STEEL
REVISION # 1

Effective: 16 September 1968

Subject: Case, Cartridge, 7.62mm, Cold Worked, Manufactured from different types of steel.

Background and Synopsis of Present Situation:

Recent proof test firing of four small lots of cartridges, assembled with cold worked cases manufactured from four different types of steel, lots B, C, D and F produced splits in the "S" and "SJ" positions.

Purpose:

To provide additional test lots manufactured from the "C" lot of steel, using modified processes.

Instructions and Requirements:

1. Process approximately 10,000 (approximately 320 lbs.) cups from Lot TMP-310-C-1 in the following manner:

a. Process as requested in TMP 310 up to and including par. 2.6

b. Anneal (new)
Furnace: Lindberg, atmosphere controlled
Temp: 1320°F
Time in furnace: 51 minutes at heat (51 minutes cooling)
Hardness: 1/16 above junction of base and sidewall on O.D. R_B 66 max.

c. Continue processing in accordance with paragraphs 2.7 to 2.14

d. Fourth Draw (par 2.15)
(1) all tooling as stated shall be utilized except for a new punch (Dwg FA 32832) which will be provided by project engineer.

e. Continue processing in accordance with paragraphs 2.16 to 2.18.

f. Pocket (par 2.19)
(1) all tooling as stated shall be utilized except the die which shall be PT 2208 or PTC 2208.

g. Head (par 2.20)

(1) all tooling as stated shall be utilized except the die which shall be PT 2215 or PTC 2215

h. Continue processing in accordance with paragraphs 2.21 to 2.24.

i. At this point the components shall be separated into two lots of equal amounts. One lot shall be designated as TMP 310-C-2 and the other as TMP 310-C-3.

j. Body Anneal (par 2.25)

(1) Lot TMP 310-C-2 shall be body annealed using the Tocco induction annealer located in Bldg 215-1. The hardness of the components after annealing shall be maintained at the following hardness range for the positions mentioned.

Location from head	Vickers hardness on unsectioned case (2½ Kg load)
1-13/32" (1.406)	257 ± 25
1-37/64" (1.578)	232 ± 10
1-3/4" (1.750)	183 ± 10
1-7/8" (1.875)	140 ± 10

(2) Lot TMP 310-C-3 shall be body annealed using the brass case mouth anneal machine. The hardness of the components after annealing shall be the same as mentioned for the induction anneal above.

k. Continue processing of both lots in accordance with paragraphs 2.26 to 2.38.

l. All gage limits and information requested in original TMP apply.

WALTER F. WEIS

APPENDIX B - COLD WORKED CASE MANUFACTURING PROCESS

7 February 1969

Subject: Case, Cartridge, Cold Worked, Manufacturing Process

Project Engineer: Industrial Services Directorate

Support Metallurgy: W. Young - J4400, Ext. 24283
E. Dougherty - J4400, Ext. 24195

Support Chemistry: G. Koltonuk - J4300, Ext. 24285
R. Manley - J4300, Ext. 24285

Background and Synopsis of Present Situation

Under TMP 310 — 7.62mm Steel and Revision #1, two lots of cold worked 7.62mm cartridge cases were produced and assembled into M62 tracer cartridges. The successful test firing of these cartridges was to be the basis for possible production of a larger pilot lot. The test firing was successful; therefore, the Director, ADEL has issued instructions to proceed with the manufacture of a larger lot with ISD assuming full responsibility for processing, quality of work, completion into cartridges, acceptance testing and packaging of approximately 50,000 Ball M80 and 20,000 Tracer M62 cartridges.

Instructions and Requirements

Using four coils of 1025 carbon steel located in Bldg. 210-1, purchased from Sharon Steel Co. for TMP-305, ISD shall, upon receipt of this process information, produce 50,000 7.62mm Ball M80 and 20,000 7.62mm Tracer M62 cartridges assembled with cold worked steel cartridge cases. These cartridges shall be completed and packaged within three months after receipt of this process information.

The cartridges shall be packed in the following manner:

a. 40,000 Ball M80 and 10,000 Tracer M62 cartridges, linked four Ball to one tracer.

b. 7,000 Ball M80, 5 round clips

c. 3,000 Ball M80, linked, all ball.

d. 5,000 Tracer M62, 5 round clips

e. 5,000 Tracer M62, linked, all tracer.

Excess cartridge cases over the requirement shall be assembled into M80 Ball cartridges with determination as to the type of pack being made at a later date.

Industrial Services Directorate shall process the strip in the following manner, using the sequence of operations, tools, inspection limits, hardness controls and solutions listed below.

1.1 Blank & Cup

Press: crank vertical, double action - Bliss No. 6
Tools: Blanking Punch, SKFSA 11205, Rev C
Cupping Punch, SKFSA 11206 Rev C
Blank & Cup Die, SKFSA 11207, Rev E
Stripper, SKFSA 11208
Stripper Spring, PT-1006
Stripper Holder, SKFSA 3582
Gage Limits: SKFSA 9863 - O.D. 0.694-0.700
SKFSA 9564 - Base Thick. 0.150 - 0.156
SKFSA 9865 - Wall thick. 0.180 inside Base - 0.107 - 0.117 .
Wall thick.var. 0.180 from inside Base-0.004 max.
Wall height var. 0.035 max.
Weight - 194 grs (approx)

Solution: 1-1/2 parts water to 1 part Lubro No. 44

1.2 Wash, Rust Prevent

Barrel: metal, rotary, inclinable, Baird
Solution: Hot water, 4 cups tri-sodium phosphate; wash for 1/2 hour;
Rust Preventive: potassium dichromate added to final rinse.

1.3 Anneal

Furnace: Lindberg, atmosphere controlled
Temperature: 1320°F
Time in furnace: 51 minutes at heat (51 minutes cooling)
Hardness: 1/16" from junction of base and sidewall on O.D. R_B 66 max.

1.4 Phosphate Coat & Lubricate

Machine: Ransomatic unit

1.5 First Draw

Press: crank, vertical, duplex, Bliss No. 62

Tools:		
	Punch	FB56669 Rev A
	Guide Ring	PT-1966A
	Top Die	PTC-1982
	Bottom Die	PTC-1983
	Stripper	PT-1294A
	Stripper Holder	PT-1005
	Stripper Spring	PT-1006

Gage Limits: SKFSA 9866 - O.D. 0.595-0.600
FB 36251 - base thick. 0.150-0.158
SKFSA 9867-wall thick. 0.437 from inside base 0.058-0.064
wall thick, var. 0.437 from inside base-0.004 max.

Drawing Solution: One (1) part Lubewell SB300 mixed with 6 parts water.

1.6 Wash, Rust Preventive Rinse & Dry

Washer: Niagara
Solution: 7.5 lbs. of Pennsalt to 200 gals of water
Rust Preventive: 3 oz of potassium dichromate added to rinse water

1.7 Anneal

Furnace: Lindberg, atmosphere controlled
Temperature: 1320°F
Time in Furnace: 51 minutes at heat (51 minutes cooling)
Hardness: 1/16" above junction of base & sidewall on OD R_B 65 max.

1.8 Phosphate Coat & Lubricate

Machine: Ransomatic unit.

1.9 Second Draw

Press: crank, vertical, single action, Bliss No. 304

Tools:		
	Punch	FB56667 Rev A
	Guide Ring	FB 52211
	Top Die	PTC- 114B or SKFSA 6803 or FB 18618A
	Lube Ring	SKFSA 10768
	Bottom Die	PTC-115A or SKFSA 6803 or FB 18618B
	Stripper	PT-1002
	Stripper Holder	PT-1005
	Stripper Spring	PT-1006

Gage & Limits: FB 22309 - O.D. 5695-.572
FB 22305 - base thick. 0.152-0.160

SKFSA 5935 - wall thick. ½" from inside base 0.049 to 0.055
Temp. Gage - wall thick. 5/8 from inside base-0.038-0.044
wall thickness var at ½ and 5/8 positions - 0.004 max.

Drawing Solution: One (1) part Lubewell SB300 mixed with 6 parts water.

1.10 Wash, Rust Preventive Rinse & Dry

Washer: Niagara - (see 1.6)

1.11 Anneal

Furnace: Lindberg, atmosphere controlled
Temperature: 1320°F
Time in furnace: 51 minutes at heat (51 minutes cooling)
Hardness: 1/16" above junction of base and sidewall on O.D. R_B 66 max.

1.12 Phosphate Coat & Lubricate

Machine: Ransomatic unit

1.13 Third Draw

Press: crank, vertical, single action, Bliss No. 304

Tools:		
	Punch	FB 56668
	Guide Ring	FB 56670
	Top Die	PTC-2203
	Lube Ring	SKFSA 10768
	Bottom Die	PTC-121A
	Stripper	PT-1003D
	Stripper Holder	PT-1005B
	Stripper Spring	PT-1006

Gage & Limits: FB 36052 - O.D. 0.516-0.519
SKFSA 9873 - base thick. 0.155-0.165
SKFSA 9874 - wall thick. ½" from inside base 0.035-0.041
wall thick. var - ½" from inside base 0.004 max.
SKFSA 9875 - wall thick. 1-1/8" from inside base 0.018-0.023
wall thick. var - 1-1/8" from inside base 0.003max.

Drawing Solution: One (1) part Lubewell SB300 mixed with 6 parts water.

1.14 Wash, Rust Preventive Rinse & Dry

Washer: Niagara - (see 1.6)

1.15 Phosphate Coat & Lubricate

Machine: Ransomatic unit

1.16 Fourth Draw

Press: crank, vertical, single action, Bliss No. 304

Tools:		
	Punch	FA 32832 Rev A
	Guide Ring	SKFSA 10770
	Top Die	FB 57128
	Lube Ring	SKFSA 10768
	Bottom Die	PTC-131C
	Stripper	PT-1004F
	Stripper Holder	PT-1005B
	Stripper Spring	PT-1006

Gage & Limits: FB 41263 outside dia. 0.4670 - 0.4682
FB 22303 base thick. 0.156 - 0.158
FB 23471 wall thick. ½" from inside base 0.031-0.036
wall thick, var. ½" from inside base 0.004 max.
FB 23471 wall thick. 1.70 from inside base 0.010-0.0135
wall thick. var. 1.70 from inside base 0.002 max.

Drawing Solution: One (1) part Lubewell SB300 mixed with 6 parts water.

1.17 Wash, Rust Preventive Rinse & Dry

Washer: Niagara - (see 1.6)

1.18 Trim

Machine: horizontal, single spindle

Tools:		
	Cutter	SKFSA 10268 or PT-126A
	Spindle	FA 30254 or PT-1904
	Sleeve	SKFSA 6118 or PT-1907
	Stripper Ring	SKFSA 6122 or PT-138
	Nut	FA 30255 or PT-1906
	Burring Cutter	SKFSA 6119 or PT-1905
	Spring	SKFSA 6123 or PT 1971

Gages & Limits: SKFSA 9871 - inside length 1.840 - 1.860

1.19 Sort

1.20 Pocket

Press: horizontal, toggle and crank

Tools:		
	Die	SKFSA 11572-2
	Eject Stem	FB 57126
	Punch	PTP2207

Gage & Limits: FB 41260 - outside dia 0.4692 max.
FB 22303 - web thick. 0.028 - 0.032
FB 22320 pocket concentricity 0.003 max.

1.20 Head

Press: horizontal, toggle and crank
Tools: Die — SKFSA 11431-1
Eject Stem — FB 57125
Punch (1pc)
Punch (2pc) — FA 33393B or PT1039C
Punch Holder — PT-1941C
Gages & Limits: FB 41247 - outside dia. 0.4698 max.
FB 22341 - pocket dia. 0.2093 - 0.2098
FB 22323 - pocket depth 0.1255 - 0.1305
FB 22303 - web thick, 0.052 - 0.062
FB 23482 - pocket concentricity 0.005 max.
FB 23380 - head crookedness 0.004 max.

1.22 Wash, Rust Preventive Rinse & Dry

Washer: Niagara - (see 1.6)

1.23 Stress Relief

Furnace: Lindberg, electric, recirculating air
Temperature: 840°F ± 10°F for 40 minutes at temperature.

1.24 Head Turn

Machine: horizontal, single spindle
Tools: Collet — PT-1008B
Spring — PT-1009
Form Tool — FB 52213 (carbide type C6)
Gages & Limits: FC2884 - head dia. 0.467 - 0.471
FC 2927 - head thick. 0.048 - 0.053
FC 2884 - Ext groove dia. 0.403 - 0.407

1.25 Vent & Deburr

Machine: WFF Primer Insert
Tools:

Burr

Punch	PT-1025
Stem	FB 18636B

Vent

Punch Holder	PT-170B
Punch	FB 36474
Die	FB 36475
Stem	FB 36476

1st No Vent Detect	
Holder	PT-176A
Clamp	PT-179A
Stem	PT-177B
Detect Pin	PT-178

2nd No Vent Detect - Same as 1st No Vent Detect

Gages & Limits: SKFSA 9868 - dia. of vent hole 0.078-0.032

NOTE: Operation and tools mentioned above are to be used when two piece heading punch is used at heading operation.

1.26 Partial Anneal (Body)

Location from Head	Vickers Hardness on Unsectioned Case (2½ kg load)	$R15_t$
1-13/32 (1.406)	250±	89+
1-37/64 (1.578)	260 ± 10	87 to 89
1-11/16 (1.687)	150 ± 15	---
1-3/4 (1.750)	150 ± 10	79 to 81
1-7/8 (1.875)	150 ± 10	79 to 81

Rockwell readings given for setup purposes only. Vickers readings to be taken after setup hardness is obtained.

Machine: Gas (Brass Case Mouth Anneal)

1.27 Phosphate Coat (Do not lubricate)

Machine: Ransomatic

1.28 Taper & Plug

Press:	Vertical, double action, crank - Bliss No. 162	
Tools:	Mouth ironing punch	PT2210A (optional)
	Mouth ironing die	PT2211A (optional)
	Mouth ironing spring	PT-1012 (optional)
1st Taper:	Shoulder Die	SKFSA-6139 or PTC1916C
	Body Die	SKFSA-6140 or PTC1915B
	Eject Stem	SKFSA-6142 or PT1918B
	Die Anvil	SKFSA-6141
2nd Taper:	Shoulder Die	SKFSA-6143 or PTC 1921C
	Body Die	PTC 1989
	Eject Stem	PT1922B
	Die Anvil	SKFSA-6141

Plug: Punch		PT-159A or SKFSA-6146
Gage & Limits	FB 23455	Concentricity of neck - 0.004 max.
	FB 23524	Max Profile
	FB 23520	Profile of body
	SKFSA-9870	Mouth dia. 0.3078 - 0.3085
	FB-23522	Length, head to shoulder 1.627 - 1.631
	FB-23460	Neck Dia. 0.3413 - 0.3433
Lubricant	Machine oil	Spec. VV-O-251

Lubricate cases by lightly wiping with cloth impregnated with oil.

1.29 Wash, Rust Preventive Rinse & Dry

Washer: Niagara - (see 1.6)

1.30 Finish Trim

Machine: Vertical, single spindle

Tools:	Cutter	PTC-1010B or SKFSA 6148
	Cutter Holder	PT-1011B or SKFSA 6147
	Support Cover	PT-1014 or SKFSA 6149
	Retainer Seat	PT-1923 or SKFSA 6150
	Case Support	FA-33876 or SKFSA 6149
	Cutter Clamp	PT-1015A or SKFSA 6149
Gages & Limits:	FB 23526 - total length 2.0003 - 2.0093	

1.31 Wash, Rust Preventive Rinse & Dry

Washer: Niagara - (See 1.6)

1.32 Visual Inspect - 100%

Machine: Horizontal, twin screw, conveyor

1.33 Iron Phosphate - To be accomplished in Bldg. 217-2 according to process to be supplied by Chemical Engineering Branch, J4300, upon request. Ref. DF dated 30 Jan 69.

1.34 Dry - To be determined by Chem Engr Branch, J4300.

1.35 Varnish - To be performed in and by the Painting Shop, X3422.

Machine:

a.	Material:	Varnish, phenolic - Spec MIL-V-12276, Type III, Class B.
b.	Viscosity:	Varnish viscosity at room temp. 26 to 30 secs, Zahn #2cup.
c.	Immersion:	Time - 1 minute approx.
d.	Centrifuge:	Time - 1 minute approx.

1.36 Varnish Cure

Equipment: Oven
Curing time - 375° to 400°F metal temperature for 30 to 45 min.

NOTE: Varnish shall have a dark greenish appearance when it is properly cured.

1.37 Visual Inspect - 100%

Machine: Horizontal, twin Screw, conveyor (Clean hoppers are mandatory).

1.38 Prime

Machine: Vertical, straight line, crank and rocker, WFF & Mch. Co.

Station	Tool	Drawing
No case detect	Detector	PT1134A
Foreign matter detect	Detector	PT1135A
	Stem	PT181A
Burr	Burr Punch	PT1025
	Stem	PT2327
No vent detect #1	Holder	PT-176
	Clamp	PT179
	Stem	PT177
	Detector Pin	PT178
No vent detect #2	Same as No vent detect #1	
Insert & Seat	Punch	PT2145
	Holder	PT2146
	Anvil	PT2147
Inverted & No Primer Detect	Detector	PT182
Seat & Crimp	Punch	FB41932
	Holder	PT2149
	Sleeve	PT2150
	Anvil	PT187
	Stem	PT186
Defective Primer Detect	Assembly	PT2344
	Detector	PT2331
	Nut	PT2332
	Stem	PT2333
Mouth Waterproofing	Assembly	PT2342
	Cup	PT2334
	Plunger	PT2335
	Body	PT2336

Station	Tool	Drawing
	Cup Spring	PT2339
	Key	PT2338
	Plunger Spring	PT1155
	Nut	PT2337
Primer Waterproofing	Assembly	PT2343
	Pin	PT2340
	Holder	PT2341

NOTE: Crimping punch shall protrude 0.018" from face of holder.

1.39 Inspect Gage & Weigh & Visual Inspect

Same machines as shown in the operations control Section pertaining to Cartridge, Ball & Tracer, NATO, 7.62mm, M80 & M62 except work shall be visually inspected as it is being discharged from each individual machine.

NOTES:

1. Industrial Services Directorate is requested to process this lot of ammunition by a continuous, uninterrupted production method.

2. Industrial Services Directorate will be responsible for all aspects of this project which shall include processing inspection, assembly, testing and packaging. At the completion of the project all information relative to process inspections, test firing, etc., shall be available upon request.

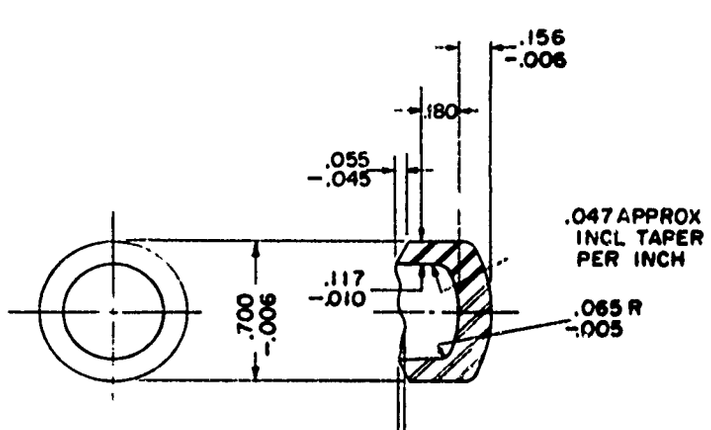
3. Mr. Walter Young, J4400, under the guidarce of Mr. Edward Dougherty, J4400, will be responsible for metallurgical evaluations at each operation to determine the metallurgical adequacy for continued processing of the components into completed cartridge cases.

4. Mr. Gregg Koltonuk, J4300, under the guidance of Mr. Robert Manley, J4300, will be responsible for chemical aspects of the project and will offer assistance upon request.

5. Mr. Rudolph Grosskurth, J7200, will provide limited technical assistance, if requested; should problem areas arise in processing.

BX 10535793

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	(1-4) SEE EO # SX 70192	11-9-67	



NOTES:-

1- WALL THICKNESS VARIATION AROUND THE PERIPHERY AT ANY SPECIFIED POINT ALONG THE CYLINDRICAL LENGTH OF THE CUP SHALL NOT VARY MORE THAN .004

(A) 2-MATERIAL:- STEEL, SPEC MIL-S-645, EXCEPT CARBON 0.22% TO 0.28%; SILICON 0.08% MAXIMUM; PHOSPHOROUS 0.025% MAXIMUM; SULPHUR 0.025% MAXIMUM. AVERAGE STRIP HARDNESS ROCKWELL B67 MAXIMUM; INDIVIDUAL READING ROCKWELL B70 MAXIMUM NO.5 TEMPER.

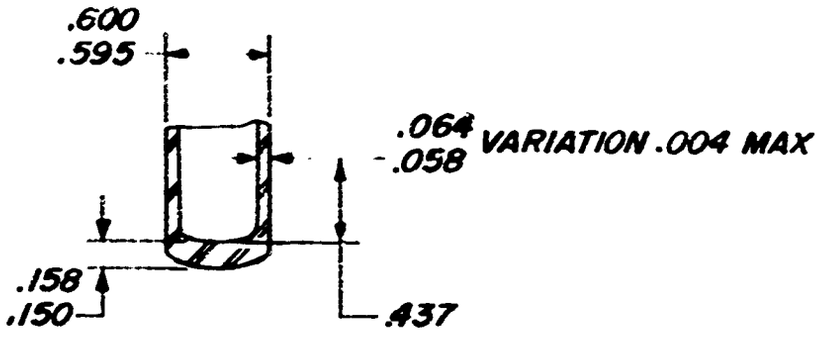
3- ROCKWELL HARDNESS OF CUP ANNEALED B65 MAXIMUM ON SIDEWALL 1/16 FROM OUTSIDE BASE.

4- UNIT WT:- 202 - 14 GRAINS.

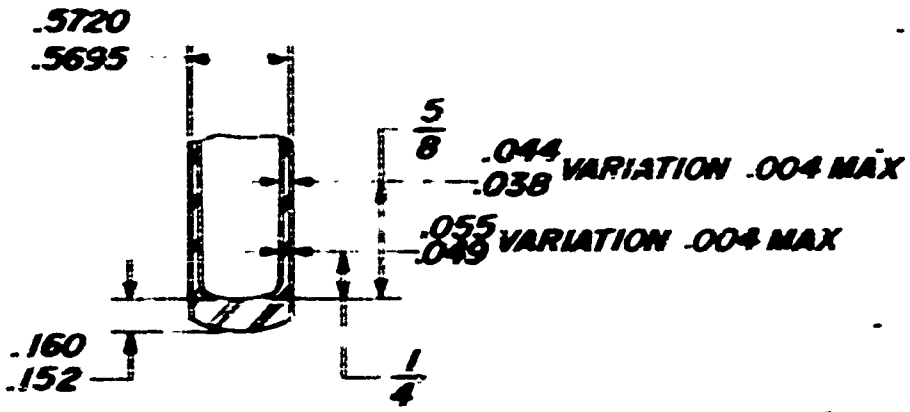
PART No. 10535793

MECHANICAL PROPERTIES: YP, TS, EL 2, RA, BH, RH NOTE 3	(A) DX10542482 CODE CIG; SEE ENGINEERING RECORDS; NEXT ASSY / USED ON; APPLICATION; DO NOT APPLY PART NO.	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES; TOLERANCES ON FRACTIONS DECIMALS ANGLES; .0 ±0.05 ±0; MATERIAL NOTE 2; HEAT TREAT; PROTECTIVE FINISH	ORIGINAL DATE MARCH 11, 1966; DRAFT; TRACED; ISSUED; SUBMITTED; APPROVED	U.S. ARMY FRANKFORD ARSENAL PHILADELPHIA PA 19137	ADEL ESA SCA	CUP
				SIZE B	CODE IDENT NO. 19200	DRAWING NO. X10535793
				SCALE 2/1	UNIT WT. NOTE 4	SHEET 1 OF 1

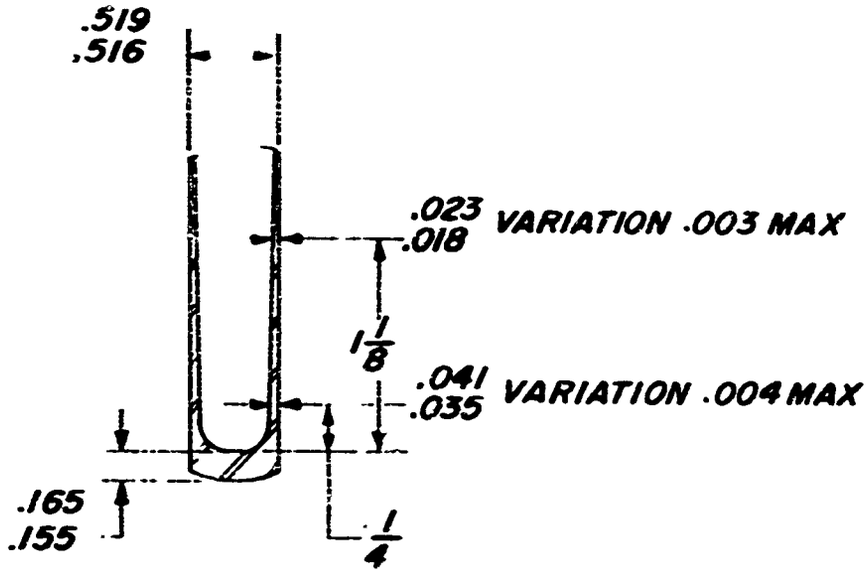
DRAWN Form C2819 11 Dec 64



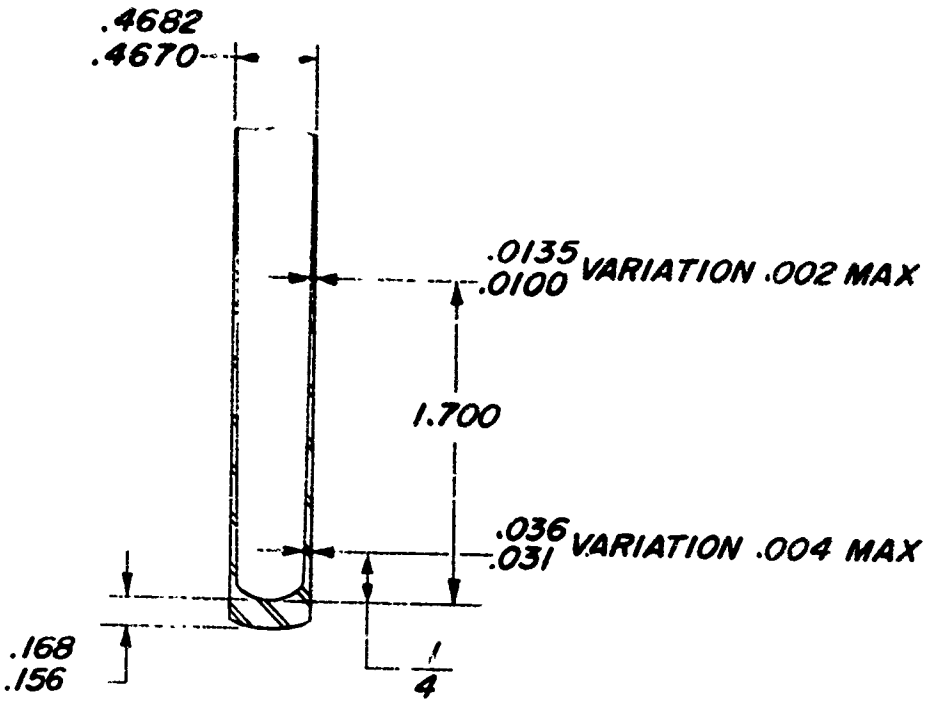
7.62MM STEEL CASE
COLD WORKED-1ST DRAW



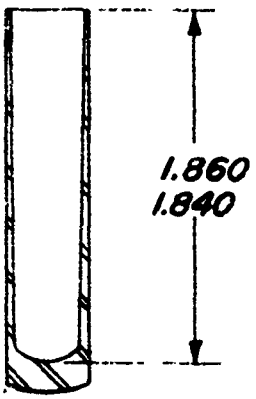
7.62 MM STEEL CASE
COLD WORKED-2ND DRAW



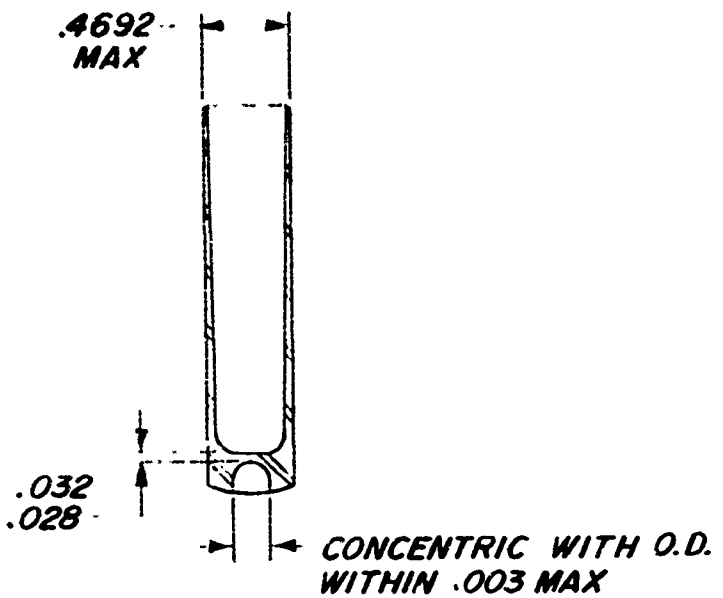
7.62 MM STEEL CASE
COLD WORKED - 3RD DRAW



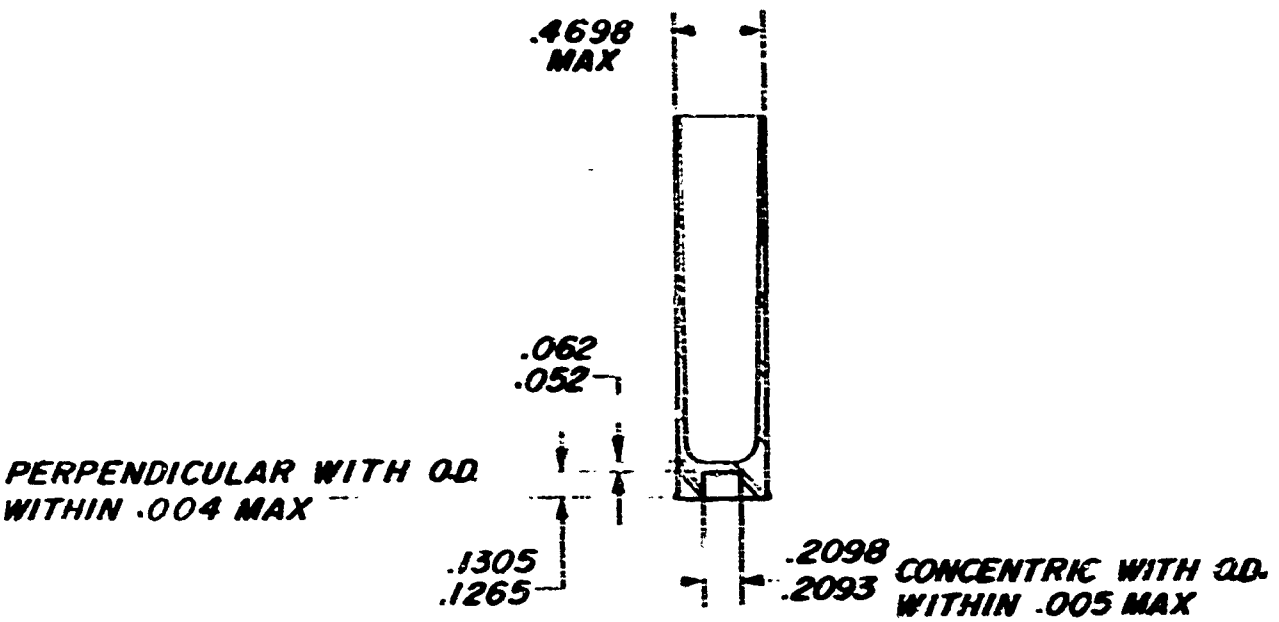
7.62 MM STEEL CASE
COLD WORKED - 4TH DRAW



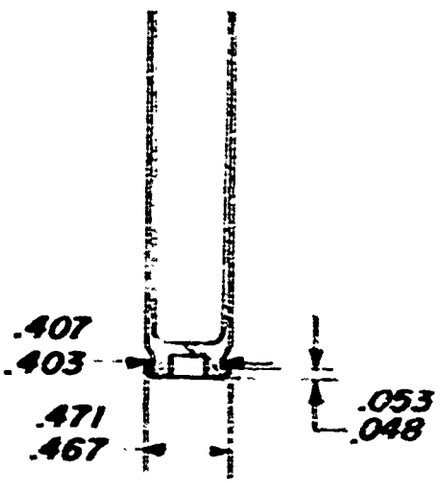
7.62 MM STEEL CASE
COLD WORK - TRIM



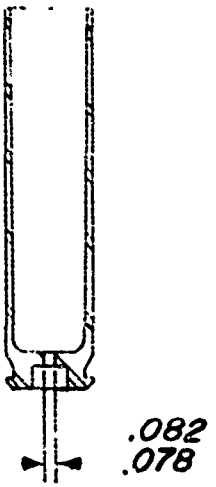
7.62 MM STEEL CASE
COLD WORKED-POCKET



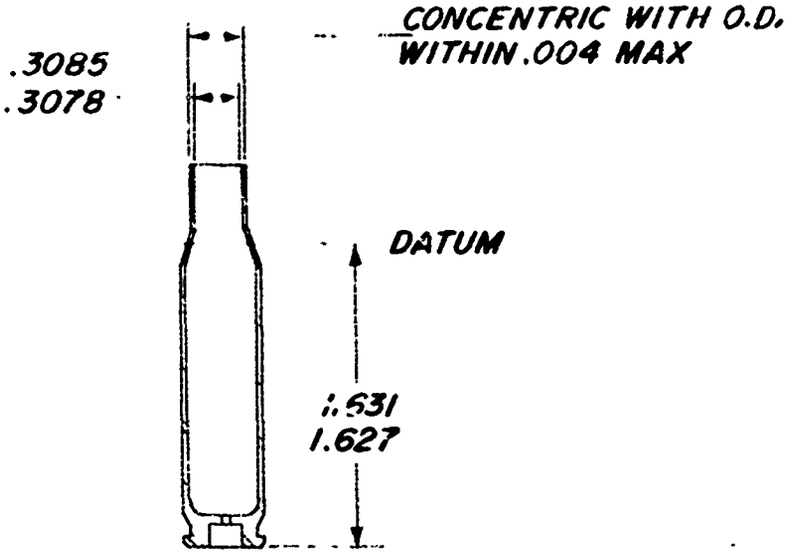
7.62 MM STEEL CASE
COLD WORKED-HEAD



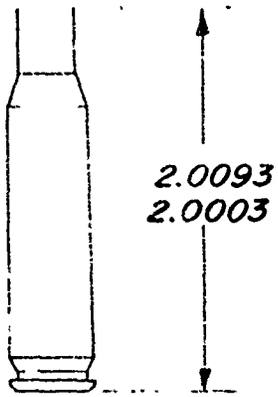
7.62MM STEEL CASE
COLD WORKED - HEAD TURN



7.62 MM STEEL CASE
COLD WORKED–VENT & DEBURR



7.62MM STEEL CASE
COLD WORKED-TAPER & PLUG



7.62 MM STEEL CASE
COLD WORKED-FINISH TRIM

UNCLASSIFIED
Security Classification

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	U.S. Army Munitions Command Dover, N.J. 07801

13. ABSTRACT

Under the Army-wide copper conservation program of 1966, Frankford Arsenal initiated a product-improvement program for the 7.62mm steel cartridge case. Two processes, heat treating and cold working, were used to obtain finished-case hardness. This report covers the latter.

The major reason for developing a cold worked case was to eliminate the purchase of expensive heat treating equipment, not presently in general use for cartridge case production, thereby reducing the cost of plant conversion.

While the Frankford Arsenal cold worked case has not been submitted to ET/ST, indications are that this case can be manufactured to acceptable tolerance levels, providing adequate controls are exercised.

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED
Security Classification

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Cartridge Cases Small Caliber Ammunition						